THURSDAY, NOVEMBER 19, 1885

LOOMIS'S "CONTRIBUTIONS TO METEOROLOGY"

Contributions to Meteorology. By Elias Loomis, LL.D., Professor of Natural Philosophy and Astronomy in Yale College, &c. Revised Edition. (New Haven, Conn., U.S., 1885.)

IT is now fifty years since Prof. Loomis's attention was directed to the study of meteorology, his interest in the subject having been awakened by Redfield's investigations respecting the phenomena and laws of storms. During the first forty years his principal writings were elaborate discussions of the great storm which occurred in America in December 1836, and an equally remarkable storm which occurred in Europe shortly after the American storm, and an account of another United States storm in February 1842, which in a part of its course was accompanied by a tornado of unusual violence. The chief outcome of these investigations was a new method of charting observations, now so familiar to all the world in our weather maps, and the demonstration of the capital fact in meteorology, that in storms the movement of the wind is spirally inwards, circulating from right to left about the centre of the cyclone.

The generally imperfect character of the barometric observations for a long time precluded all attempts at any satisfactory investigation of the storms and weather of the United States; and it was not till 1871, when the Signal Service was organised, with its uniform methods of observation and reliable barometers, that the data required for the investigation was supplied. When two years' observations had accumulated, Prof. Loomis resumed his inquiries, and from July 1874 a series of papers by him, entitled "Contributions to Meteorology" have appeared from time to time in the *American Journal of Science*. A large number of these we have noticed in NATURE as they appeared. As the subjects investigated were taken up without any regard to systematic order, and as a change of views has necessarily come about as the investigations proceeded, Prof. Loomis has wisely resolved to reduce them to a more systematic form and incorporate into the revised work the results of observations now available, not only from the United States, but also from Europe and other parts of the world. The present pamphlet contains the first chapter of this revision, and the subject dealt with is the areas of low atmospheric pressure, their form and magnitude, and the direction and velocity of their movements.

As regards the forms of areas of low pressures, or cyclones as they are conveniently termed, the greatest and least diameters of all the cyclones represented on the Weather Maps of the Signal Service during a period of three years were actually measured, with the result that the average ratio of the longest diameter to the shortest was 1·94. In 53 per cent. of the whole number of cases the ratio was 1·5; in 33 per cent. 2; in 11 per cent. 3; and in 3 per cent. 4. Similarly the Atlantic storms, as delineated on Hoffmeyer's charts for a period of three years, have been examined, and the measurements show that the ratio of the longest diameter of the cyclones to the shortest is 1·70; and that while in 54 per cent. of the whole number of cases the ratio was 1·5, in 17 per cent. it was 2, and in 1 per cent. 3—thus showing a marked deficiency of very elongated low pressure areas over the Atlantic Ocean as compared with the United States.

Observations show that the longest diameter of cyclones may be turned in any azimuth. In the States it is most frequently directed towards a point somewhat East of North, the point towards which the longest diameter is most frequently directed being N. 36° E. The average direction is sensibly the same for the cyclones of the Mississippi Valley and for those of the Atlantic coast. Over the Atlantic Ocean the direction of the longest diameters are more equally distributed in azimuth than they are in the United States, but the point towards which the longest diameter is most frequently directed is N. 35° E, which corresponds almost exactly with the direction found for the United States.

The cyclones of the tropics frequently exhibit a violence greater than is ever known in the storms of the middle latitudes, but their geographical extent is comparatively small. The inclination of the winds inwards upon the centre is shown to be more strongly marked in tropical cyclones than in most storms of the middle latitudes. From an examination of the weather maps of the Signal Service it is found that in the United States a low pressure area, with only one system of cyclonic winds, frequently has a diameter of 1600 English miles, and Hoffmeyer's charts show that cyclones over the Atlantic have frequently diameters of 2000 English miles. Widespread areas of low barometer, having several centres of cyclonic action, may have a diameter of 6000 English miles or may even form a belt extending nearly, if not entirely, round the globe between the parallels of 40° and 50° N. lat. On the other hand, tropical cyclones are often only 500 miles in diameter, and are occasionally of still less dimensions.

When low pressure areas are very much elongated, two or three cyclonic centres are frequently included within the same area of low pressure. Though these cyclonic centres are occasionally of equal depth, yet they are more generally of very unequal depth and intensity. The weather charts of the morning of March 9, 1876, showed a very large area of low pressure overspreading Europe and the Atlantic Ocean, having a principal centre of low pressure in the north of Scotland, around which violent winds prevailed, rising to 12 on Beaufort's scale, with very steep gradients on the western side of the cyclone. About the same time, and within the same widespread low pressure area, there were four other cyclones, with their centres at St. Petersburg, South Russia, south coasts of the Black Sea, and over the Caspian Sea, respectively.

As an illustration of one of the more extensive areas of low pressure, Prof. Loomis adduces the great barometric depression of June 7, 1882, as shown on the International Weather Map of the Signal Service of that day. This area of low pressure covered the whole of Asia, apparently extending from the equator to a considerable distance beyond the North Pole; it covered the whole of Europe with the exception of a small portion of its southern margin, and also the northern part of the Atlantic Ocean and stretched across the central portion of North America to the Pacific Ocean: thus extending

through 320 degrees of longitude. The principal low centre, 29·200 inches, was north of the Caspian Sea; a second low centre, 29·400 inches, was over the northern part of India; a third low centre, 29·600 inches, over the Gulf of St. Lawrence; a fourth low centre, 29·800 inches, over China; a fifth low centre, 29·800 inches, north-east of Japan; and if every part of this large portion of the earth's surface had been sufficiently represented by observing stations several other subordinate low centres would doubtless have been exhibited. On the other hand, a centre of high pressure, 30·400 inches, was found over the Atlantic Ocean; a second, 30·200 inches, over the south-eastern part of the United States; and a third, over the eastern part of the Pacific near latitude 30° N. The area of high pressure formed a belt closely following the parallels of 30°—35° and extending through at least 240 degrees of longitude, but interrupted by the Asiatic Continent.

We drew attention five years ago to the all-important bearings of these areas of high and low pressure on the weather in all the regions of the globe over which anomalously high and low barometers at any time prevail (NATURE, vols. xxi., xxii. and xxiii.). But the importance of this department of meteorology is much enhanced when it is considered that it is through a careful record of the appearance and disappearance in different regions of the globe of these cyclonic and anti-cyclonic areas and an investigation of the causes determining their form, position, and intensity from time to time that we may hope to reach the solution of the problem of the weather. In prosecuting this large inquiry, the results of Prof. Loomis's careful measurements of meteorological phenomena, as detailed in the revised edition of his "Contributions" now before us, form one of the best guides we at present possess.

Direction of Movement of Areas of Low Pressure.—Areas of low pressure, or cyclones, seldom remain stationary in the same position for many hours. The centre of low pressure generally changes its position steadily from hour to hour, and everywhere there is observed a marked uniformity in the direction of this movement. Prof. Loomis gives several charts showing the progressive movement of cyclones in different parts of the world, including one showing nearly all the different storm tracts delineated on the International Weather Maps of the United States Signal Service for a period of more than four years. Maury's Storm Charts are also brought under review. The lowest latitude reached by the centre of any cyclone, which has been distinctly traced, is 6° 1′ N., and there are only eight cases of cyclones whose paths have been traced to points south of lat. 10° N.

Observations indicate that, both in the Pacific and Atlantic, gales are of extremely rare occurrence within six degrees of the equator, and, when they do occur, the barometric depression is small, and the cyclonic character of the winds indistinctly marked. But in low latitudes, a little higher than six degrees, gales are more frequent over the Pacific than over the Atlantic Ocean.

Tropical storms which are found to pursue a westerly course are limited to two regions of the globe—viz. the Atlantic Ocean, but particularly its western portion, near the West India Islands, and the region south of the continent of Asia. As regards the Pacific, no cyclone has ever been observed, except near Asia or its outlying islands.

As regards the tracks of tropical cyclones in the neighbourhood of the West Indies, the teaching of the data represented on the International Charts is that nearly all the areas of low barometer which occur within the tropics and advance westwards, instead of following the ordinary course of the trade winds, advance in a direction somewhat north of west. Of these West Indian cyclones, 88 per cent occurred in August, September, and October, thus leaving only 12 per cent. for the other nine months of the year. On the other hand, of the Asiatic cyclones 52 per cent. occurred in September, October, and November, and 43 per cent. in April, May, and June, thus leaving only 5 per cent. for the other six months. There is, therefore, a marked seasonal difference as to the frequency of the tropical cyclones of the Atlantic as compared with the Pacific: in the Atlantic they are almost exclusively confined to the autumn, but in the Pacific they are nearly as frequent in spring as in autumn.

The average direction of the course of the Asiatic cyclones, while moving westward, is 38° north of west, which closely accords with that found for West Indian cyclones. But, as regards the onward progress of tropical cyclones, whilst Asiatic cyclones advance westwards at the average rate of 8 English miles per hour, the average velocity of West Indian cyclones is double that amount. Asiatic cyclones come around to a due north course about lat. 19°·8 N., but West Indian cyclones do not assume a due northerly course till, on the average of instances, lat. 30° N. is reached. In the Pacific the average course of cyclones, after turning eastward, was 35° E. of N., and their velocity was 9·8 miles, which is scarcely half of the velocity of the West Indian cyclones. These striking and vital differences between the tropical cyclones of the Atlantic and the Pacific will doubtless play no unimportant part in the development of the theory of the cyclone.

An examination of Prof. Loomis's chart of storm-tracks for the northern hemisphere, with wind charts indicating the prevailing direction of the wind, shows a remarkable correspondence between the two classes of facts. Examining the point more narrowly, Prof. Loomis finds that for the middle region of the Atlantic, near lat. 50°, the average direction of storm paths corresponds very closely with that of the average direction of the wind; but in the western part of the Atlantic the average course of storms is considerably more northerly than that of the wind, while in the eastern part it is more southerly. These results, which fairly accord with those derived from tropical storms, seem to indicate, in the opinion of the author, that in the middle latitudes of the northern hemisphere the direction of progress of storm-centres is not the same as that of the average wind, but is sensibly affected by some other causes; and that the results derived from observations in the China Sea indicate that one of the causes is the prevalent direction of the wind which immediately follows a storm. The subject is further prosecuted by an examination of the prevailing winds and storm-tracks during the three winter months for the ten winters ending 1882 of that portion of the United States between long. 90° W. and the Rocky Mountains. The result of this somewhat exhaustive comparison is similar to that derived from the observa-

tions on the Atlantic—there being observed no rigorous correspondence between the average direction of the movement of storm-centres and the prevailing wind; but that in some regions the average course of storm-centres is more northerly than that of the wind, and in some regions more southerly.

While in middle latitudes the generally progressive movement of cyclones is in an easterly direction, cyclonic areas are occasionally observed, both in Europe and America, advancing to westward. After a careful investigation of forty-one of the most decided cases which have occurred of these westerly movements of cyclones, it is considered that the following conclusions are warranted—viz. that the westerly movement of low-pressure centres is due to a fall of rain or snow, in most cases unusually great, in the region towards which the low centre advances; and the influence of one low-pressure area acting apparently as an attractive force upon another adjacent low-pressure area; to the influence exerted by two areas of high pressure, not far apart, by which a new movement is imparted to the air included between them, a new low centre being sometimes developed; or to the influence of a high pressure on the north-east side of a low-pressure area, when the gradients on the south-west side of the low area are slight, in which case the centre of the low-pressure area may be crowded towards the south-west.

Rate of Progress of Cyclones.—The rate of progress of the United States storms for thirteen years has been calculated, and the results arranged according to the months, and expressed in miles per hour. The average rate of progress for the year is 28·4 miles, rising to the maximum, 34·2 miles in February, and falling to the minimum, 22·6 miles, in August. As regards different years, the variation is also much greater in the winter than in the summer months. Thus, in November, 1878, the rate was 21·2 miles per hour, but in the same month of the following year it was 40·7 miles; and, on the other hand, in July, 1882, the rate was 19·8 miles, but in July, 1881, it was 26·6 miles—the difference between the extremes of November being thus 19·5 miles, and in July only 6·8 miles.

In Europe during the five years ending 1880 the mean annual rate of progress was 16·7 miles, rising to the maximum, 19·0 miles, in October, and falling to the minimum, 14·0 miles, in August. Hence the onward movement of storms in the United States is two-thirds greater than in Europe, the rate of excess for the United States over Europe being 1·9 in winter, and 1·5 in summer. On the mean of the year the average onward movement of storms is, in miles per hour, 28·4 for the United States, 18·0 for the middle latitudes of the Atlantic, 16·7 for Europe, 14·7 for the West Indies, and 8·5 for the Bay of Bengal and the China Sea.

Prof. Loomis is led to conclude that the general system of atmospheric circulation, consisting of the trades of equatorial regions and the westerly winds of the middle latitudes, is the primary cause which determines both the direction and velocity of the movement of storm centres; but as respects each individual storm, the determining cause is not so much the average system of atmospheric circulation, as the general movement of the atmosphere going on at the time, and in the vicinity of that particular storm. The influence of this general movement is, moreover, materially modified by a variety of causes, among which may be enumerated the rainfall, and the position of the region over which it falls with respect to the centre of the storm; the size and position of neighbouring areas of high and low pressure, the distribution of temperature, and the physical configuration and character of the surface.

In further prosecuting this important discussion, the time has perhaps now come for meteorologists to give more consideration and weight to the physical conditions of the cyclone, more particularly to the method of distribution of temperature and aqueous vapour within and in the more immediate neighbourhood of the cyclone. This point, which was so strongly dwelt on and urged by Dove, has for some time past been allowed to fall too much into the background. A cyclone is not merely a system of low pressure with winds all around blowing vorticosely inwards upon the centre; but it is further distinguished by this, that the atmosphere in front of its path is relatively warm and moist, and in the rear cold and dry. These features are seldom kept so steadily in view by meteorologists as they ought to be in the discussion of such questions as Prof. Loomis has here brought under review.

One outstanding difference of the storms of America and those of Europe is that nearly all of the American storms originate on the continent, not far from the Rocky Mountains, whereas the storms of Europe originate mostly on the ocean. It is not improbable that more than one of the important points of difference between these two classes of storms shown by Prof. Loomis have their explanation in the different conditions under which they have their origin.

OUR BOOK SHELF

A Treatise on the Calculus of Variations. By L. B. Carll, A.M. (London: Macmillan, 1885.)

A Text-Book on the Method of Least Squares. By Mansfield Merriman. (London: Macmillan, 1885.)

BOTH these works by American mathematicians have been, we believe, printed in America, and are now introduced to the attention of English students by Messrs. Macmillan. They are first-class representatives of the good work now being done in this field: we have (NATURE, vol. xvi. p. 21, vol. xxvi. p. 59) already given account of other American mathematical publications.

Mr. Carll, on his title page, states that his treatise is "arranged with the purpose of introducing, as well as illustrating, its principles to the reader by means of problems, and designed to present in all important particulars, a complete view of the present state of the science." The subject is one which certainly has not engaged the time of our book-compilers, for which good and sufficient reasons might be assigned. In 1810, as Todhunter writes, a work was published by Woodhouse, which has obtained a high reputation for accuracy and clearness. That work was not followed by any systematic treatise in English until the year 1850, when Mr. Jellett brought out his valuable "Elementary Treatise on the Calculus of Variations," an octavo volume of 377 pages, with an introduction of 20 pages. In the later editions of Mr. Todhunter's integral calculus are given such portions of the subject as are generally read by students. The same writer's "History" and "Researches" should be in the hands of all who desire to get up this branch thoroughly. After the lapse of so long an interval as thirty-five years

we are not surprised to find that Jellett's work is difficult of access to general readers, and on this ground, if on no other, we welcome the present attempt to bring the "Calculus" to the fore again. The author follows Airy and Todhunter in the view he takes of a variation, and Jellett and Strauch in the treatment of varying functions, but he has not neglected to give fairly full accounts of the conceptions and methods of other writers.

A good deal of the preface is taken up with details which might well be omitted should the work reach a second edition, as we hope it may.

There are in all five chapters (568 and xvii. pages) printed in good type and in excellent style.

Chapter i., maxima and minima of single integrals, involving one dependent variable is broken up into ten sections: Chapter ii., maxima and minima of single integrals involving two or more dependent variables in two sections: Chapter iii., maxima and minima of multiple integrals in six sections. Chapter iv., applications to determining the conditions which will render a function integral one or more times in two sections.

Chapter v. gives a historical sketch of the rise and progress of the calculus of variations founded upon Todhunter's "History," and closes with an account of the "Researches in the Calculus of Variations," referred to above.

We have nothing to say of Mr. Merriman's work in addition to what we have said already (NATURE, vol. xxx. p. 334): the works are identical, except in the title pages.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Italian Aid to Biological Research

THE Committee appointed by the Royal Academy of the Lincei in Rome at the request of H.E. the Minister of Naval Affairs, to see that the best possible use in the interests of science be made of the natural history specimens collected by officers of the Royal Italian Navy, wishes to make known to all students of biology that rich material for study, consisting of a certain number of plants and extensive collections of animals of nearly all classes, is at present deposited at the Zoological Station at Naples. This material has all been collected by the officers of the Royal Navy, principally by the *Vittor Pisani* in a recent voyage round the world, and by other Italian men-of-war in the Red Sea and the Ægean Sea. These collections have been preserved by the best and most modern methods, and can be used for histological and morphological researches, in accordance with the actual requirements of science, as well as for systematic and faunistic investigations. The Committee places this rich material at the disposal of the men of science of all countries who will ask to take part in its illustration, either to complete monographs in course, or for monographical works or for special research on any organic system of a given group.

The requests, on which the Committee will decide, are to be sent to Prof. Trinchese, University of Naples.

Prof. TRINCHESE, Naples
Prof. TODARO, Rome
Prof. PASSERINI, Parma
Prof. GIGLIOLI, Florence
Lieutenant CHIERCHIA (Royal Italian Navy), Naples
Prof. DOHRN, Naples

The Resting Position of Oysters

IN a letter from Mr. J. T. Cunningham in your impression of NATURE of October 22 (p. 597) it is sought to show that the oyster does not rest on its left but on its right valve. The evidence which appears to him conclusive on this question is "that the right flat valve is always quite clean, while the convex valve is covered with worm-tubes (*Stylea grossularia*) and Hydroids."

This observation is correct on the whole, but not decisive for the question under consideration. After reading Mr. Cunningham's letter I proceeded to examine 140 oysters in my collection of Schleswig oysters, and found only on a few right valves a worm (*Pomatoceros tricuspis*) or a Cirripede (*Balanus crenatus*), whereas on many *left* valves I distinguished sponges (*Halichondria panicea*), *Alcyonium digitatum*, Hydroids (*Sertularia argentea*, *Tubularia indivisa*, *Eudendrium rameum*), Bryozoa (*Alcyonidium gelatinosum*), *Balanus crenatus*, *Pomatoceros tricuspis*, or *Sabellaria anglica*. Of the 140 oysters examined 43 still bore on their shells the body on which as spawn they had reared themselves, namely pieces of oyster-shells, *Mytilus edulis*, *Mya arenaria*, *Mya truncata*, *Cardium edule*, or *Buccinum undatum*. All these adherent bodies were attached to the nucleus of the left valve, not one single piece to the nucleus of the right. And this is a circumstance decisive in the question raised by Mr. Cunningham. The places on the right valve, where living animals rest, did not stick close to fixed bodies, but the water flowed freely over them, thus admitting embryos to settle on them. The bottom of oyster banks is not a smooth surface, but is formed mainly of old oyster-shells on which many living oysters do not assuredly plant themselves closely and horizontally, but lie often obliquely. It is thus that Hydroids, Sponges, Alcyonium, and Alcyonidium, having settled on the right lower valve, are enabled to grow freely in the water and without let or hindrance develop to the length of four or five inches.

Kiel, October 31 KARL MÖBIUS

Universal Secular Weather Periods

I DO not want to pose as a statistical cycle-hunter, or to bolster up any mere apparent local periodicity of a certain meteorological element, but I wish to place before your readers the appended independent paragraphs from two journals, one on each side of the Atlantic, and to ask any unprejudiced person if we have not here some preliminary evidence (all the more valuable from its being so evidently incidental and unconscious) in favour of the march of certain secular weather areas, possibly connected with barometric waves, similar to those traced out by Messrs. Chambers and Pearson in India, across the Atlantic, from America to Europe.

I would not submit such slender evidence to criticism were it not that it concurs entirely with certain views put forward by myself in a recent paper in the Royal Meteorological Society's *Quarterly Journal*, on "The Height of the Neutral Plane of Pressure in India," and that I have long felt that the entire question demands attention both on scientific and economical grounds. Also both paragraphs include last year, thus bringing the apparent periodicity up to date.

Being at present fully engaged in two other branches of research, I am unable just now to take up this hopeful and important problem, but I would suggest that if we ever intend to forecast the *general character* of the weather of a season or year, which even in this country undergoes long periodic changes, during which it remains for weeks and months together of the same *type*, some such method as the following must be adopted:—

Annual and seasonal mean barometric charts must be constructed from records at principal stations in America, Europe, and Asia for the past fifty or sixty years, and from them barometric abnormals for each year, and for each season, must be calculated, and charted. An examination of these ought to throw great light on, if not to some extent solve, the question of the motion of the larger pressure areas which in turn guide and control the motion of the smaller diurnal systems. The work would, I admit, be one of some considerable magnitude, but surely it is one imperatively demanded in the interests of the science, besides being *a priori* likely to yield valuable results. It has long been a cherished idea of mine to endeavour to carry out the scheme myself, and it is only because I feel precluded from doing so at present by the pressure of other work that I throw out the suggestion for the benefit of any who feel disposed to take it up.

The paragraphs are as follows :—

Mr. Baldwin Latham, in a discussion which ensued upon the Report of the Committee on Decrease of Water Supply (*Quarterly Journal* Roy. Met. Soc., p. 223), said :—

"The records showed that there appeared to be a recurrence of low water every ten years. There was lower water in 1824 and in 1835; the period 1844–5 was low, especially when compared with the years immediately before and following; 1854 was remarkably low; also 1864–5, 1874–5, and now they come to the present low period of 1884–5.

"As to what was the cause of this marked periodicity it was very desirable to ascertain, and, having pointed it out, probably some light might be thrown on the subject."

The other is from the *American Meteorological Journal* under the heading "Cold Winters in Michigan," and the writer says :—

"It is interesting in this connection to notice that the local reports of extremely cold winters place them at intervals of between ten and eleven years. . . . The winter of 1842–3 is thus shown to have been extremely cold; also the winter of 1853–4; the winter of 1863–4 noted for its terribly cold new year; the winter of 1874–5, when the frost penetrated into the ground in Port Huron four to six feet, there being scarcely a thaw between January 1 and the middle of March; and, lastly, the winter of 1884–5, which beats the record for extreme cold during January and February."

I may add that before I had seen either of these paragraphs I had concluded from other sources that the years 1821–2–3–4, 1833–4, 1844–5, 1866–7, and 1875–7 were characterised by mild winters in Europe and unusual cold in Iceland and America, being preceded in most cases by drought during the summers; but of course this represents merely the result of a preliminary glance at some general records of noteworthy seasons.

November 9 E. DOUGLAS ARCHIBALD

Photography of the Corona

I HAVE been following with interest the communications which have been made from time to time to *Science* by Mr. W. H. Pickering regarding the photography of the corona in full sunshine. Whilst admiring the manner in which he has built up his theoretical objections to its possibility, I am forced to dissent from his deduction from the fact that the theory does not fit in with the results actually obtained during the eclipses observed in Egypt and the Caroline Islands. I have in my hands at present spectrum and other photographs of the corona made during the expeditions to those localities, and from them I gather he has evidently much underestimated the photographic brightness of the corona as compared with that of the sky. As I propose shortly to read a paper before the Royal Society on the subject, I cannot enter into details at the present moment. All I will say is that the comparative photographic intensity of both can be estimated with approximate exactness from the data I have by me.

I write this for insertion in your columns, as in your last issue you have a note regarding Mr. W. H. Pickering's communications on this subject. W. DE W. ABNEY

Permanence of Continents and Oceans

MANY naturalists are accustomed, in lecturing, to speak of the existing ocean basins as "permanent." Though this must to a large extent be a true statement, many geologists at all events must be perfectly aware that the former distribution of life requires that nearly all lands, however remote at present, must have been, perhaps more than once, in connection with each other. Tropical South America is perhaps the most isolated continental province now existing. I would ask these naturalists to explain how its species of tropical genera not peculiar to it got there, and how many of them came to be represented in Europe in Tertiary times.

That the lands are always chiefly centred about the same spots, and also the converse, would, I think, be an acceptable way of putting it; but that the Atlantic was never bridged except towards the Arctic and Antarctic circles, is a statement that is unwarrantable because contradicted by unimpeachable evidence. J. STARKIE GARDNER

History of Elasticity

IN order to estimate Poncelet's services to the theory of elasticity I am extremely desirous of examining certain works by him. These works are not to be found in the London or Cambridge Libraries, and the Paris booksellers to whom I have applied despair of being able to procure copies. It will hardly be possible for me to go to Metz to examine them before the publication of the first volume of the "History of the Mathematical Theories of Elasticity." Possibly some of your readers may know of the existence of accessible copies in this country. If so, I should esteem it a great favour if they would communicate with me at University College.

In 1827–29 Poncelet gave at Metz a "Cours de Mécanique Industrielle aux Artistes et Ouvriers Messins." In this "Cours" various important points of theoretical elasticity were considered for the first time.

It was published as follows :—

(*a*) Part I. Lithographed edition, Metz, 1827.

(*b*) Part II. First edition lithographed 1828; second edition lithographed 1831.

(*c*) Part III. Lithographed edition, 1831.

(*d*) Part I. First printed edition, Metz, 1829; second printed edition, Metz, 1831.

It is needful to remind your readers that there are numerous other works entitled "Mécanique Industrielle," by Poncelet, published at Liége, Paris, and Brussels, differing from each other, and entirely from the above. These I have examined, but they do not contain what I require. KARL PEARSON

University College, London, November 15

The Heights of Clouds

In the very favourable notice of our "Mesures des Hauteurs et des Mouvements des Nuages," in NATURE of October 29 (p. 630), there exists a misunderstanding as to the probable errors of our measurements, which makes our observations seem much more inexact than they really are. I therefore ask your permission to correct it.

Mr. W. de W. A. says: "Perhaps one of the most easily-observed clouds is the cumulus, and we find from a table given that the *probable error of observation* is very considerable." But, in fact, what is there referred to as an error of observation is not such an error; it is the probable uncertainty ("incertitude probable") *depending on the variability of the phenomenon itself*.[1] This is expressly stated in the treatise. On p. 39 (that following the table quoted) there may be read: "L'incertitude calculée comprend ainsi et celle dépendant de la variation des hauteurs des nuages, et celle provenant des erreurs d'observation. Celle-ci est cependant assez petite par rapport à la première et à peu près constante pour les différentes heures du jour, comme on le trouvera en la calculant séparément à l'aide des erreurs moyennes *m*." That mean error *m* is just the *mean error of observation* in the height of a cloud, and in our "list of observations" we have given it for every observation, as well as the corresponding mean angular error of the observation. By calculating the probable error of an observation of cumulus by means of those values of mean errors we have found it to be 35 *metres* (instead of 748 metres, as Mr. W. de W. A. thinks it to be), and the probable error of the mean is found to be 3 metres (instead of 40 metres), the whole number of observations being 134.[2]

Thus the above assertion is fully justified, viz. that the errors of observation may be quite neglected when compared with the uncertainty depending upon the variability of the heights of the cumuli from one cloud to another. That variability is itself a phenomenon worthy of investigation, varying as it does according to the hour of the day and the barometrical state of the weather, and that is the reason for which we have calculated it. As to the mean angular error in observing a cloud, we have found it very often to be inferior to that obtained in observing the centre of the sun, and in all the better observations that error is fully comparable to the error in observing the sun, as may be seen from our treatise. This proves that, for such observations, the uncertainty of an identical point of cloud did not exist at all, the whole uncertainty depending on the unavoidable instrumental errors. Still it may be that the errors are

[1] For the figures in the table quoted represent simply the *probable difference* of an observation (of the mean found) from the *true* mean calculated by the method of least squares.

[2] For the higher clouds, as the pure cirri, this error was often very great indeed, but it was so because their distance was much too great when compared with our basis, the parallax obtained being not greater than 1° or 2°. This year (1885) the measurements are regularly pursued from the ends of a basis of 1302 metres, and we can now determine with great accuracy the height even of the most elevated cirri, as well as their horizontal and vertical velocities.

somewhat less in using a photographic theodolite than in using our instruments. But on the other hand our method enables us to observe the clouds even in twilight and moonlight, in rain and storm. Also, it is, no doubt, much cheaper than the photographic one.

N. EKHOLM

Upsala, November 6

The Helm Wind

SOME years ago I passed a summer at Melmerby, which is about the best place for seeing the "helm," which is incorrectly described as affecting the Penrith valley (for, in fact, it never extends to Penrith) by your correspondent, M. Woeikoff.

Melmerby is at the foot of the Cross Fell range, and gets the "helm" with great violence. When an easterly wind comes on, the summit of Cross Fell becomes clouded; *it puts on its helm:* then from this a violent cold wind pours down the hillside (which is steep) and rises up again at no great distance. At Melmerby, and places similarly situated, there is clear sky, for the moisture in the sky is invisible, but further from the range it is precipitated where the current rises, and there is cloudy sky, without the strong wind. The phenomenon is, in fact, precisely that at Table Mountain, where the cloud on the crest is called the "table-cloth."

Judging from M. Woeikoff's description there seems to be a difference in the phenomena. Probably owing to the *gentle slopes* of the Varada chain the air does not seem to *rise again*, and there is no cloud-bank parallel to the chain. It would seem, too, that the wind extends to the *west*, unless there is a misprint.

J. F. TENNANT

37, Hamilton Road, Ealing, W., November 13

THE MODE OF ADMISSION INTO THE ROYAL SOCIETY

OUR contemporary *Science*, in the last number which has reached this country, makes some remarks concerning the admission of candidates into the Royal Society, against which, in the interests of truth and accuracy, it is our duty to protest, the more especially as it is also implied that the French system of canvassing those who are already Fellows of the Society is also adopted.

The statements actually made are (1) that there is an "actual competitive examination, on the result of which a certain number of successful candidates are annually chosen," and (2) "that the English method has the additional disadvantage that it does not secure the men whom it is most desirable to honour." We read also, "During the schoolboy period the distinction between different individuals is a distinction of learning, and an examination is not unfitted to discover the boy who deserves reward. But learning is not the quality which a State needs to make it great. Casaubons are not the kind of men who have built up English science. The qualities which ought to be encouraged, and which it should be a nation's delight to honour are qualities too subtle to be detected by a competitive examination."

For the benefit of our transatlantic brethren we may as well state the facts as we know them. For reasons into which we need not enter here, as they do not affect the question at issue, nearly forty years ago the Royal Society determined to limit the yearly admissions to fifteen; and to throw upon the Council the responsibility of selecting the fifteen who are to be nominated for election, a general meeting of the Society reserving to itself the right of confirming or rejecting such nomination. It may be instructive to remark that for thirty years that right has not been exercised.

The way in which the matter is worked is as follows:—The friends of a man, who are already in the Society, and who think he is entitled to the coveted distinction, prepare a statement of his services to science, in many cases without consulting him in any way. This paper thus prepared is sent round to other Fellows of the Society, who are acquainted with the work of the candidate, and who sign it as a testimony that they think he is worthy of election. In this way when the proper time arrives some fifty or sixty papers are sent in to the Council for their consideration. In the Council itself we may assume that the selection of the fifteen is made as carefully as possible in view not merely of individual claims but of the due representation of the different branches of science. It is not for us to state the safeguards or mode of procedure adopted, but we think we may say that the slightest action or appeal to any member by the candidate himself would be absolutely fatal to his election. Finally, we may say that, years back, when a heavy entrance fee had to be paid, there were cases in which the question had to be put to one whose friends were anxious to see him elected, whether he would accept election. The small yearly subscription of 3*l.*, now the only sum payable, makes even this question unnecessary at the present time.

ON MEASURING THE VIBRATORY PERIODS OF TUNING-FORKS

THE tuning-fork when its number of double vibrations, to and fro, in a second, or briefly its *frequency*, has been ascertained, is a most convenient instrument for measuring minute divisions of time. As such it is now extensively used for physical, physiological, and military purposes (velocity of bullets and cannon balls). The antecedent difficulty of ascertaining the frequency, is however very great. The old processes, sufficient for roughly ascertaining musical pitch, and depending upon wires of known weight, length, and tension, or the action of the siren, are totally insufficient for modern purposes. It was the contradictory nature of the results furnished by the monochord in the division of the Octave into twelve equal parts that led Scheibler to his system of a series of tuning-forks differing from one another by known numbers of vibrations, leading to countable beats, and extending over an Octave. Nothing can be more convenient to use than such a series of forks for all musical purposes. They enable the frequency not only of any small as well as large tuning-fork, but also of any sustained tone to be ascertained within one-tenth of a vibration, that is, one vibration in ten seconds. The writer has for some years been in the constant habit of using such a set of forks with the most satisfactory results. His own forks were measured by Scheibler's (exhibited in the Historic Loan Collection of Musical Instruments at the Albert Hall this year), but extend over a greater range, from about 224 to about 588 vib., that is, rather more than an Octave and a major Third. The great advantage of such a tonometer is extreme portability, immediate application to any sustained tone (even that of a pianoforte string), and the independence of the result from any (almost always imperfect) estimation of unison by a musical ear. There are of course antecedent difficulties in ascertaining the pitch of each particular fork, but these are overcome by patient observation, the extension of the series beyond an Octave furnishing in itself the required check.

Scheibler died in 1837. In 1879 Prof. Herbert MacLeod and Lieut. R. G. Clarke, R.E. (*Proc. R. Soc.*, vol. xxviii. p. 291, and *Philosoph. Trans.*, vol. clxxi. p. 1) invented an optical arrangement, which under proper management (but the manipulation was very difficult) gave excellent results for large tuning-forks, like those of Koenig. And in 1880 Koenig (*Wiedemann's Annalen*, 1880, pp. 394-417) invented a clock method for ascertaining with extreme accuracy the frequency of one large standard fork of 64 vib. at 20° C. Before both Prof. MacLeod and Dr. Koenig, Prof. Alfred Mayer, of Hoboken, New Jersey, U.S., had invented a most careful and ingenious electrographic method, of which a full account has just appeared in vol. iii. of the *Transactions* of the National Academy

of Sciences, U.S.[1] Briefly this last method consists, first, of making the tuning-fork itself, by means of an added style of extreme tenuity, scribe its vibrations as sinuosities in a curve on a revolving cylinder of smoked paper, an old conception; and, secondly, of determining the exact number of such sinuosities as occurred in a second, by means of electricity, which was entirely new, and in which lies the pith and difficulty of the method.

When in 1879 the writer was collecting materials for his "History of Musical Pitch" (*Journ. of Soc. Arts*, March 5 and April 2, 1880, and January 7, 1881), it became necessary to verify Scheibler's forks, and to do so he had five large forks constructed, giving the pitches of certain forks preserved in the Conservatoire at Paris. These forks he measured with great care by Scheibler's tonometer, and then Prof. MacLeod measured them by his process, after which they were sent to America to be measured by Prof. Mayer (the particulars of his measurements of these forks are given in his paper cited above), and on their return they were remeasured by the writer with the scribing-points on, and by Prof. MacLeod with the scribing-points on and off, in order to ascertain the flattening caused by the scribing-points, and also any losses that might have been occasioned by the journey. The sum of the two affected only the second place of decimals, except in one fork, where they amounted to 0·2 vibrations. By adding these, and also correcting for temperature, the result was an agreement of all the three methods within 0·1 vibrations.[2]

But Prof. Mayer's results are given to three places of decimals, which it would be extremely difficult to check, not only because of the delicacy of the measurement, but on account of the alteration of pitch by temperature, and the uncertainty which prevails over the coefficient of alteration. Thus for 1° F. Prof. Mayer considers this coefficient to be ·00004638, or 1 in 21561; Prof. MacLeod takes 1 in 20,490, and Dr. Koenig as 1 in 16,097, or in 16,112, or 16,000. The writer's own experiments, between 59° and 175° F., gave 1 in 18,280. For all ordinary purposes 1 in 20,000 may be conveniently used. But the coefficient certainly alters with the size, shape, and quality of the fork observed, and hence it is necessary to correct each observation for temperature separately, before taking the mean, as Prof. Mayer has done. Under these circumstances, at most 2 places of decimals (perhaps only 1) out of 3 of Prof. Mayer's means can be trusted. That is, it is doubtful whether his process for measuring the frequency of tuning-forks is superior to Scheibler's, properly carried out.

The difficulties of the process, which caused Prof. Mayer much trouble to overcome, may now be referred to. The kernel of the method consists in a very exact assignment of the beginning and end of each second on the sinuous curve of vibrations. This is obtained from a clock, the rate of which has to be ascertained. Its pendulum is armed with a point which cuts through a globule of mercury in a cup, screwed up to be small and rigid, and, as this globule rapidly becomes oxidised, by the passage of electricity, it must be renewed for each experiment. The spark from the inductorium at every contact of the pendulum and mercury, must make a *single* perforation of the smoked paper covering the cylinder. To effect this the strength of the current must be carefully regulated, as otherwise a great number of holes may be made. The paper is very interesting on this point, which is well illustrated by experiments and a diagram. Other precautions are necessary, but the above two are the most important. The primary coil of the inductorium and the clock (through the pendulum and globule of mercury) are placed in the circuit of a voltaic cell. The fork and cylinder (separated from the style by the thickness of the smoked paper) are placed in the secondary circuit of the inductorium. The work of the fork on the paper in scribing was found not to flatten by more than ·004 vib. The flattening from the appended scribing-point was shown by Prof. MacLeod's measurements of the writer's forks to vary from ·021 to ·0475 vib. It therefore always sensibly affected the second place of decimals, showing that the results for determining the frequency of an unarmed fork, when the effect of the arming could not be determined (as it cannot be by Prof. Mayer's method), could not be trusted beyond one decimal place. This limit can be reached very simply without all this apparatus and these precautions, by simply counting the beats of good forks within beating distance of each other. Prof. Mayer's method, therefore, does not surpass Scheibler's for simply determining the frequency of tuning-forks, but is fully equal to it, provided the forks are sufficiently large. Neither Prof. Mayer's nor Prof. MacLeod's process is applicable to small forks. The writer is doubtful whether the passing of a current through one prong of the fork and not the other may not affect the period of the fork. The necessity of screwing the fork on to a block (as indeed of screwing it into a resonance box) is always dangerous from the possibility of twisting the prongs. The writer has known of a fork which was thus considerably altered. The frequency of a fork screwed on to block in this way is not the same as that of a fork on a resonance box. Prof. Mayer has himself, in his paper, determined that the amount of correction for support and scrape may amount to − ·026 vib. Prof. Mayer does not renew the excitation with a bow during the same observation, as Prof. MacLeod had to do, and he has shown that the frequency is practically independent of the amplitude of vibration.

Prof. Mayer did not himself apply his instrument to determine the frequency of forks generally, but, as he states in the title of his paper, specially as a chronoscope. In that case the above difficulties disappear. What is wanted to know is the exact number of vibrations of the scribing-fork as it scribes, affected by all the circumstances mentioned—screwing, scribing, passage of electricity, &c. We are not in the least concerned to discover the frequency of the unscrewed, unarmed, unelectrified fork. Even temperature is of no consequence, provided it be uniform during the experiment. The velocity of rotation of the cylinder is also immaterial, provided it be constant for one double vibration, which can hardly help being the case for such a small fraction of a second. There is only one source of error, the inequality of the seconds' pendulum, arising from the globule of mercury being of a sensible magnitude, so that an appreciable time is occupied in traversing it (eliminated by counting the sinuosities for every two seconds instead of every second), and the inevitable want of true centering of the globule and pendulum (eliminated by taking a mean). Prof. Mayer's arrangement then becomes an extremely simple and also an extremely accurate means of measuring short intervals of time within, to a certainty, one-hundredth of a vibration of the fork. Thus, if the fork gives 400 vibrations in a second, the measurement would be correct to one-forty-thousandth part of a second!

Prof. Mayer concludes his very valuable and interesting paper—which is recommended to the attention of all experimenters requiring accurate chronoscopic observations—with showing the arrangement for experimenting with this chronoscope "on the velocities of fowling-piece shot of various sizes projected with various charges of powder from 12- and 10-gauge guns," with a diagram giving the

[1] "On a method of precisely Measuring the Vibratory Periods of Tuning-Forks, and the determination of the Laws of the Vibrations of Forks; with special reference of these Facts and Laws to the Action of a Simple Chronoscope."

[2] Prof. Mayer measured, at temperatures varying from 63·3 F. to 69·25 F. The standard temperature of the writer was 59° F. = 15° C., the temperature at which the Diapason Normal in Paris has been settled. It may be mentioned that in Prof. Mayer's tables xiii. and xiv. of this paper, the titles have been transposed; the first related to the Tuileries fork, 434 vib., and the second to the Feydeau fork, 422·8 vib., and not conversely as printed.

position of the wires and make-circuit lever, and tables of the results, and says, finally :—

"The simplicity and inexpensiveness of the chronoscope we have described in this paper, its accuracy, and the ease with which it is used, must commend it to all who will give it a trial under the conditions of the action which we have endeavoured to set forth in this paper. Another of its advantages is that its records on the paper covering the cylinder are easily rendered permanent by drawing the unsmoked side of the paper over the surface of a dilute solution of photographic negative varnish contained in a wide shallow dish. On the records may be written with a blunt style the nature of the experiments they record before the carbon is fixed by the varnish, and then they can be bound together in book-form for preservation and reference."

ALEXANDER J. ELLIS

HINTS ON THE CONSTRUCTION AND EQUIPMENT OF OBSERVATORIES FOR AMATEURS

IF it were necessary to offer any apology for the short series of articles of which the first is now presented to the readers of NATURE, it might be found in the fact that, so far as I know, nothing fulfilling the above title has been put into circulation in England for more than forty years. This is the more remarkable when one considers the great development of astronomy in this country during the present generation, a development the credit of which is far more due to amateur effort than to the influence of Governments or public establishments. The reason I have fixed upon the year 1844 is that that was the year in which Admiral Smyth published his well-known "Bedford Catalogue of Celestial Objects," to which he prefixed certain chapters dealing with the construction and management of small observatories.

Those chapters have never been reproduced in any form, partly, no doubt, for the reason that they are a good deal out of date; but they are still capable of furnishing many useful hints to any one who wishes to write on the subject of observatories.

It is not too much to say that the Bedford Observatory has directly or indirectly served as the model for nearly all the private observatories of moderate dimensions since erected in England, and it is equally certain that, whatever may be the changes which considerations of finance, or architecture, or geology, may render expedient in particular instances, no important alterations need be made in the main features of the Bedford Observatory, although upwards of half a century has elapsed since it was erected, and more than forty years have passed away since it was pulled down.

In order to compress as much information as possible into a small compass I propose to classify what I have to say in such a way as shall successively conduct the reader step by step through the stages which he himself will have to pass through between the time when he determines to erect an observatory and the time when he finds himself the happy possessor of the completed building. Of telescopes as such I shall here say nothing, and the only other prefatory remark which seems requisite is this: that an amateur astronomer with only a given and moderate sum of money to lay out will do well to appropriate an adequate part of his funds to the purchase of a fairly good stand and of a suitable structure in which to house his instruments, rather than spend too much on his tube and then be obliged to starve the stand and to put up with inadequate shelter from the weather or no shelter at all. To begin, therefore, at the beginning.

The Choice of a Site.—As to this the amateur will probably in most cases be obliged to suit himself as best he can. If his garden offers any varieties of site, he should endeavour to secure one on slightly rising ground, with an uninterrupted horizon to the south (for meridian purposes) and to the west (for comets and inferior planets in the vicinity of the sun at sunset). A clear horizon to the east is of less moment, unless searches for comets before sunrise are intended to be systematically carried out.

In making preparations for building an astronomical observatory—and occasionally, indeed, for other purposes—it is necessary to know how to set out a meridian line. Of course this may be done by means of a mariner's compass (correcting for the magnetic deviation); but there are other ways of doing this independently of a compass, and as it is not always easy to ascertain the deviation a statement of at any rate one of these other ways, as given by Challis, will be useful. Set up a pole at the spot through which the proposed meridian line is required to pass, using a plumb-line to ensure the pole being vertical. Draw around the pole as a centre several concentric horizontal circles, and mark the points of coincidence of the extremity of the shadow of the pole with these circles both before and after noon. Then if the two points on each circle be joined by a chord the mean of the directions of the middle points of the chords from the pole will be approximately the direction of the meridian line. This method answers best about midsummer when the sun's diurnal path is high in the heavens, and the change of declination is small. A little forethought must be displayed in suiting the dimensions of the circles to the height of the vertical pole employed.

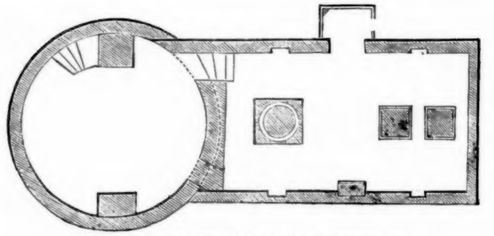

FIG. 1.—Ground plan of the Bedford Observatory.

Foundations.—The foundations of an observatory are a matter of great importance, and unless a rock[1] or chalk bottom can be readily obtained, an artificial bottom of concrete, more or less thick according to the height of the intended superstructure, must be made. This of course applies to the piers which are to carry instruments. In the case of the observatory itself, especially if the material of the fabric is to be of wood, which is so often used, the ordinary precautions against settlement taken by a competent builder will suffice. As no fire-place is permissible in an observatory because of the disturbing currents of air to which fires give rise, special precautions must be taken to protect the building and its contents against damp, and the consequences thereof. In heavy clay soils clear away the soil all around the outside of the observatory by making a trench, say 10 feet wide and 4 feet deep, and fill up the excavation with broken bricks, coarse gravel, or other hard porous material. Provide by suitable gutters and pipes, that all rain-water falling on the observatory shall be carried away to a distance as quickly as possible.

Details of the Structure of the Observatory.—Fig. 1 represents the ground plan and Fig. 2 the elevation of the Bedford Observatory. The external dimensions were about 35 feet by 13 feet 6 inches. The building was divided into two apartments: (1) an equatorial room, circular, and 15 feet in diameter on the inside; and (2) a transit-room, 17 feet by 12 feet on the inside, and 10 feet

[1] A rock foundation is not necessarily the most stable possible, and some authorities deem a sandy substratum best.

high. At Bedford the transit room contained a transit circle and a transit instrument, with a clock so placed that it could be used with either, as wanted; but an ordinary amateur will only need to have one meridian instrument, and the surplus space may advantageously be partitioned off to form a calculating-room, or the

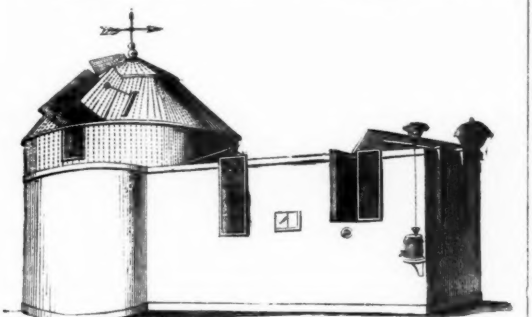

FIG. 2.—Elevation of the Bedford Observatory.

space may be used as an ante-room, and the entrance door put there, and not on the north side, as at Bedford.

It will now be convenient to describe the several parts of an observatory more in detail.

The Equatorial Room.—The equatorial being the principal instrument in every amateur's observatory, the provision made for its accommodation deserves attention first. It is not an uncommon practice to arrange that the floor of the equatorial room shall be 2 feet or 3 feet below the level of the adjoining room, and where a large equatorial is worked with a small transit instrument used merely for setting the clock, and economy and difficulties of site have to be considered, a sunken equatorial room may be unavoidable. But all the same the practice is highly inconvenient and ojectionable. An observer should be able to move rapidly from one part of his observatory to another in the dark, and without having to think of steps up or steps down. Moreover, in order to secure free internal ventilation nothing more substantial than a green baize curtain should separate the equatorial room from the transit room, and it is obviously not safe to use such

FIG. 3.—Diagram showing ribs of a dome intended to be covered with copper or sheet iron.

a curtain where it will conceal a difference of level of 2 feet or more.

Fig. 1 contemplates an equatorial of what is called the "English" form, with two separate piers for the support of the polar axis; but this construction of equatorial has become almost obsolete, owing to its numerous practical disadvantages, and the "German" form, with one pier and pillar, centrally placed, is now all but universally used, at least by amateurs.

The construction of a roof for an equatorial room (technically called the "dome," whatever may be its precise form) is a great *crux* to the intending builder of an observatory. Theoretically the hemisphere is the proper form, and roofs truly hemispherical are occasionally met with; but they are extremely troublesome and expensive to make, and can only be tackled by professional engineers.

Fig. 3 represents the skeleton framework of such a dome of large dimensions, before the sheet copper, or other material to be employed in covering it, has been been put on. Of late years, especially for large observatories, "drum" domes have come much into use as comparatively easy to construct, and capable of being made strong and watertight; but they offer much resistance to the wind, and architecturally are bound to be ugly.

For the purpose of protecting the smaller sizes of equatorials, say those from 4 inches to 7 inches in aperture, a polygonal dome is recommended. Or, in the case of equatorials of the smallest size, say from $2\frac{1}{2}$ to 5 inches, the roof of the equatorial room may be flat, and arranged to open by sliding it to one side. Such a sliding roof should not be quite mathematically flat but should have a slight inclination, to throw off the rain.

Whatever be the form of the dome chosen the problems,

FIG. 4.—Wooden Observatory erected at Eastbourne in 1854.

how to uncover a slit in it, and how to move the whole of it, are matters which require in all cases careful consideration. Where the dome is a large one, say more than 12 feet in diameter, the shutters which close the slit should slide. They may slide laterally on a suitable staging (as in Fig. 4), or they may slide up and down. The latter is a very convenient expedient, especially when the observatory is to be erected in a situation exposed to strong winds, or when the telescope is to be much used on the sun; for the observer can open just so much space as will uncover the whole aperture of the telescope, and can keep himself and the greater part of his telescope protected from the direct impact of the wind, or the direct rays of the sun, as the case may be. When arranged in the best form the shutters will be three or four in number, each protecting a third or a fourth of the slit, measured vertically. Each shutter must have its own rabbet, and its own ropes and pulleys, in order to enable the observer to open at one time only so much of the whole slit as is necessary to enable him to scrutinise the particular portion of the heavens which he desires to examine. The advantage of thus being able to shelter himself and his telescope will soon be appreciated in windy weather, or under a meridian sun by the owner of an observatory fitted with sliding shutters.

Another important matter is the question of the bearings on which a dome is to be mounted. Large domes can only be made to move with facility by the aid of mechanical appliances which are often in practice both complex and cumbersome, and needing much muscular effort on the part of the person who has to move the

dome. Where the weight of this does not exceed a ton, a set of grooved wheels running ina concave wall-plate of iron generally works well. For weights beyond this, special mechanical appliances must be used, which it is foreign to my present purpose to treat of. On the other hand, light domes—by which is meant domes up to, say, half a ton—are best dealt with by being mounted on iron balls (cannon balls in fact) travelling on a circular wall-plate, and kept in place by an upper plate, the arrangement being such as is indicated in Fig. 5.

The ironwork may be simplified in character and lessened in weight if the upper plate, which in Fig. 5 is, like the lower one, a solid casting, is replaced by two detached rails about an inch square in section and placed about 3 inches apart. The balls need only be three in number where the diameter of the dome does not exceed 10 feet. If the diameter is greater than that a fourth ball may be desirable in order to distribute better the weight, and lessen the risk of the framework of the dome being strained. The diameter of the balls may be 4 or 5 inches (say 24-pounder or 32-pounder balls), and the more truly spherical they are the less the friction, and consequently the less the muscular effort, required to impart motion to the dome; and to this it may be added the less likely are the balls to approach one another after being some time in use and so in a sense dismount the dome. When this does happen the dome must be slightly prised up by means

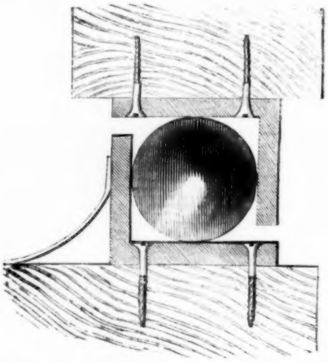

FIG. 5.—Section of bearings for a dome (Bedford Observatory).

of a lever or jack, and the balls separated and set at a distance from one another of 120° or 90°, according as there are three or four of them.

Where the dome is a light one, mounted on cannon balls, motion may be imparted to it by the simple process of pushing a long and strong handle which descends from the roof to a sufficient distance towards the floor; in other words, which is 4 feet or 5 feet long. Where a handle of this sort is used it should be affixed to the dome by strong screws or bolts, exactly opposite the shutters which cover the main opening, because when so placed the observer can grasp the handle and bring the openings exactly to that part of the heavens to which he has pointed his telescope, and can be sure that he has done so. In this facility of being able to watch how far the dome is moved resides the great advantage of the fixed handle; its disadvantage is that the observer in moving the dome has to follow it himself by walking around on the floor. To obviate this inconvenience, such as it is, some prefer a fixed wheel permanently attached to some one place in the wall of the observatory, and having cams in its periphery to catch suitable pins attached at short intervals to the inside circumference of the revolving dome.

Whatever may be the form of the dome, it is evident that in plan it must at the bottom be circular, and that the wall-plate must be circular also, and of the same dimensions. But the plan of the equatorial room, as regards its walls and floor, is another question. Where the room is large, say 15 feet or 20 feet, or more, in diameter, it will be best that it also should be circular, or perhaps octagonal. Where, however, the dome is not more than 12 feet across, and consequently the whole establishment is on a small scale, there are great advantages in making the equatorial room square. In such a case the corners will be found very useful for various purposes: for instance, in one a desk or writing-slab may be fixed; in another, the clock; in a third, a lamp; whilst the fourth corner may take a chair or a stool. In other words, the corners become available as places of refuge for things and persons whilst the observer is turning the dome round from one part of the heavens to another. Moreover, the cost of building a square room is less than the cost of building a polygonal one, because the difficulty is less, be the material brick or wood. If wood is employed for the walls of an observatory, it will in all cases be desirable to place the frame on a dwarf wall of brickwork rising at least 2 feet above the general level of the ground.

The floor must be supported on joists, trimmed so as to form square frames around the piers which are to carry instruments. This will enable the floor-boards to be fixed firmly, yet quite clear of the piers, and will prevent tremors, caused by persons passing over the floor, being conveyed to the piers, and so to the instruments. A free circulation of air must be secured by means of small brass ventilating gratings suitably disposed around the floor near the walls.

Making due allowance for the different purposes for which it is to be used, many of the remarks just made with respect to the equatorial room will apply also to the transit room. The main part of the roof is a fixture, but an opening about 1 foot 6 inches wide has to be made right across the top, and to be continued into the north and south walls from the eaves downwards towards the floor, so as to enable the observer to sweep the meridian with the transit instrument from the south horizon through the zenith to the north horizon. The openings must be protected by shutters, which may either slide or lift. For large observatories Grubb has devised a form of balance shutter which swings, and is said to work well.

In cases where the top transit shutter, which constitutes part of the roof, is in the form of a flap and lifts, it must be counterpoised by a weight or weights travelling up and down inside the room. The vertical shutters must be treated as casements, and be fitted with handles and fastenings accordingly. The remarks made in speaking of the equatorial room as to the advantages offered by sliding shutters or sashes, apply equally to the case of sliding shutters for a transit room.

Light should be obtained for an observatory by independent windows, and not, as in Fig. 2, by panes of glass inserted in the shutters; for glasses are very apt to get broken by the constant moving of the shutters.

The transit instrument as such I need not describe in detail, but it may be worth while to show how a transit instrument is mounted where space is no object, and the instrument is intended for the determination of Right Ascensions rather than for the commonplace purpose of setting a clock.

The transit instrument at Bedford consisted of a telescope of $3\frac{1}{2}$ feet focal length furnished with an object-glass whose aperture was $3\frac{1}{4}$ inches; the telescope was supported by broad cones forming an axis 28 inches long, the pivots of which rested on covered Y's offering a surface of polished Brazilian pebble an inch in bearing, and which (owing to their bases being hemispherical and working in corresponding sockets) held their proportionate weight, as well as ensured the axis of the pivots being always strictly in the same right line. The Y's

were placed on improved chucks whose azimuthal and vertical motions were effectually secured from dust and injury, and left the shoulders of the pivots just sufficient room for moving without friction; the Y's were morticed upon 2 piers of Portland stone rising 5 feet 7 inches above the floor, and which with their bases weighed a ton each. The axis of the instrument was perforated at one end in the usual way for the admission of light from a lamp at night, but it also contained a contrivance for regulating, by means of a milled head on the telescope tube, the light falling on the wires; and there was, moreover, a rack-screen to the lamp for the same purpose. In the optical focus were five principal vertical wires (besides two for the Pole-star) crossed by one horizontal wire; with a slide and divided scale for bringing the axis of the eye tubes exactly over the respective wires, and thereby destroying parallax. This part of the tube was also fitted with a simple means for adjusting the eyepiece to the solar focus, and for taking out the frame bearing the spider lines in case they needed examination or repair. For setting the telescope the eye-end was furnished with two circles, 6 inches in diameter, each provided with a level and showing altitudes and zenith distances. But it is strongly recommended that such circles should in all cases be graduated and adjusted so as to show declinations.[1]

Setting circles attached to the eye-ends of telescopes are so extremely convenient for approximate settings that it is a matter of surprise that they are not more generally used. They are thought to have been invented by Troughton, and to have been first applied in 1816 to the Greenwich transit instrument. As to this, Smyth has a note as follows:—"Mr. Jones lent me a note-book of the

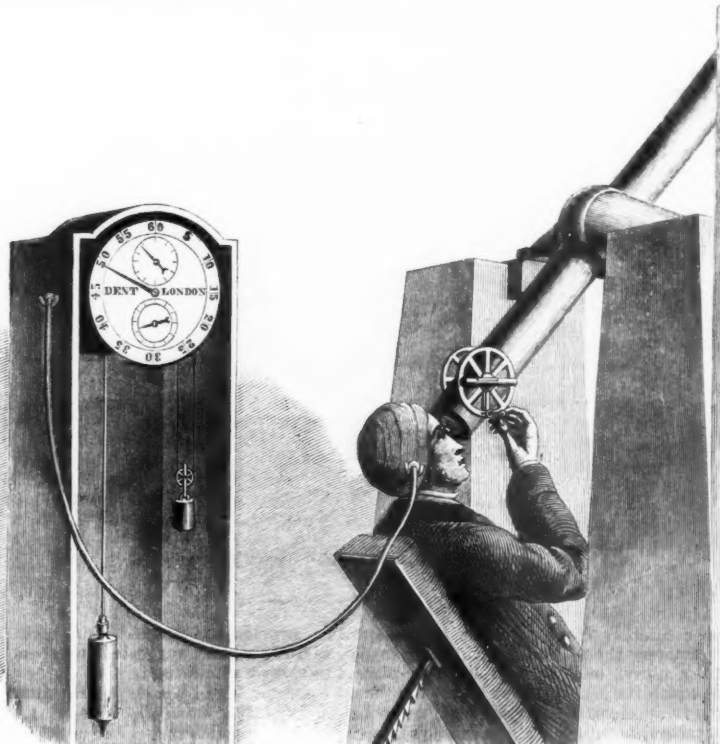

FIG. 6.—The transit instrument of the Bedford Observatory, with observing chair and clock.

late Mr. Walker, of *Eidouranion* memory, in which he describes a visit he made to the celebrated Jesse Ramsden in 1780; and mentions that he was shown an ingenious mode of elevating a transit instrument by a circle of about 3 inches diameter and a level at the eye-end. The vernier fixed and the circle with its attached level movable. To this statement is the sketch of a telescope so fitted, the accompanying portion of which I traced."

Meridian Mark.—This is an accessory to the transit instrument, so useful and so convenient that it is a matter of surprise that a meridian mark is not more generally provided in connection with transit instruments. It affords by day, and, if illuminated, also by night, a means of verifying the meridian adjustment of the transit instrument. Fig. 8 represents the meridian mark used in connection with the Bedford Observatory. A plate of brass about 4-10ths of an inch thick, 5 inches long, and 3 inches wide was fastened by four screws, passing through its corners, to a stone, into which four brass sockets to receive them had been made fast by molten lead. On this plate it was arranged that another of the same thickness should slide; this was 3½ inches long by 1½ inches broad, and was attached to the former by dove-tailed side-pieces, and was capable of being adjusted by two long screws pressing against its ends. In the sliding plate there were four slots to receive four capstan-headed screws, by means of which the sliding-plate could be firmly made fast to the fixed plate after the mark had been duly adjusted to the meridian. This done, the end screws were withdrawn to prevent the possibility of their

[1] If information is needed as to how this is to be brought about reference may be made to Challis's "Lectures on Practical Astronomy," p. 26.

being tampered with and the mark displaced from the meridian. On the sliding plate there was soldered a square piece of silver exhibiting a well-defined black cross, the centre of which was to mark the actual meridian. As this cross taken by itself hardly afforded sufficient vertical length for comparing the wires of the transit a small circle of silver (with a black dot in its centre) was placed above the cross as an auxiliary mark. This silver circle, like the larger silver plate below, was capable of lateral motion by means of capstan-headed screws which

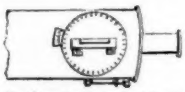

FIG. 7.—Setting circle devised by Ramsden.

could be removed when the dot had been brought exactly over the cross below. The stone to which the mark was fixed was firmly morticed into a dwarf pier, to guard against lateral movement, and the whole superstructure was firmly bedded on a solid substructure sunk into the earth. It is of the utmost importance to guard against settlements likely to cause any lateral movement, for it must be remembered that with a 50-foot radius a displacement of about 3-1000ths of an inch is equivalent to one second. The remaining and important part of the arrangement at Bedford was a 4-inch lens of $49\frac{1}{2}$ feet focus, being exactly its distance from the diaphragm. This lens was mounted in a brass collar, and having been attached by screws to a plate of cast-iron, was let into the wall of the transit window in a line with the transit instrument and the meridian mark. It is evident that the rays of light from the meridian mark become parallel after passing through the lens, and that the diaphragm can therefore be viewed through the telescope of the transit instrument as adjusted to solar focus. Another consequence of the rays being rendered thus parallel, is that no parallel motion of the transit axis would cause a change in the place of the object seen, so that the meridian is a line drawn from the *diaphragm* through the axis of the lens; and provided that these two points remain rigidly permanent, they offer all the advantages of a very distant meridian mark. And after all, a distant mark when obtainable can still be used as a check to the home mark. It will often happen that an observer will be able to find at the distance of a mile or two, or even of several miles, some well-defined line or point—*e.g.* a window sash, or the pinnacle of a church, or a piece of squared stone, which will serve him as a meridian mark for the simple reason that it lies in the meridian of his transit instrument.

Clocks.—A clock is a very important article of furniture in every observatory.

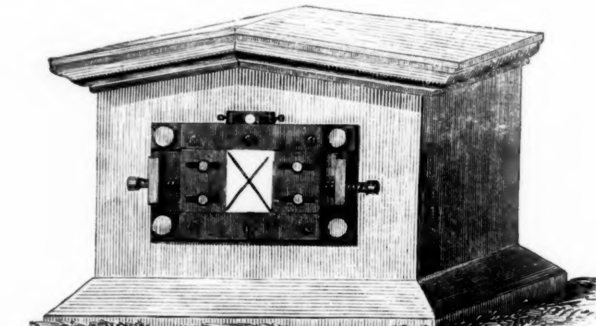

FIG. 8.—Meridian mark.

Whilst a proper sidereal clock showing twenty-four hours is what an amateur should have, he can very easily make shift with a much less pretentious time-piece, especially if his equatorial is provided with the best modern form of driving clock which only requires to be set once, or occasionally, during an evening's work. Indeed all that is essential in such a case is really a good dining-room clock (with its pendulum adjusted to sidereal time) which once set at the commencement of an evening by means of a transit instrument can be depended upon to maintain a tolerably even rate for half a dozen hours. The price of sidereal clocks for observatory purposes has been much reduced of late years, and from 20*l.* to 30*l.* will now command a fairly good one.

Where an observatory includes a transit room the clock should of course be placed so as to be visible both to an observer sitting at the transit instrument and facing the direction in which transits are most usually taken (that is, for the northern hemisphere, south) and also visible to an observer working with the equatorial. This desirable combination makes it expedient that the equatorial room should be at the west end of the buildings; but local reasons connected with the site of the observatory may not always render this possible.

For the clock there should be provided a stone pier constructed and isolated with much the same precautions as those already suggested in respect of the piers prepared to carry the telescope.

On the top of the clock case there is sometimes placed a "Hardy's noddy." This is a small and sensitive inverted pendulum inclosed under a glass bell and standing on a frame provided with three adjusting screws to level it. The use of the noddy is to discover whether the pendulum of the clock imparts any motion to its supports. But this is a refinement with which in a general way amateur observers need not concern themselves.

Meteorological Instruments.—Although an astronomical observatory is one thing and a meteorological observatory is altogether another thing, yet every astronomical establishment should be provided with a few of the more ordinary meteorological instruments, even though their owner does not profess to be a meteorologist. All astronomical observations are in a measure affected by changes in the temperature and humidity of the air; consequently, a self-registering maximum and minimum thermometer, a hygrometer, and a rain-gauge should be regarded as indispensable accessories to every observatory. No doubt, also, the desirability of having a barometer will naturally suggest itself, though its astronomical usefulness is very small indeed—by which I

mean that changes of pressure only require to be taken account of in the very exact instrumental observations carried out in first-class observatories. It is also important that a respectable weathercock should be in sight, for the direction of the wind exercises, as is well known, a potent influence on the condition of the air, as revealed by the scrutiny of a celestial object through a telescope.

A good "Six's" thermometer is quite good enough for general purposes, although not a self-registering instrument of the highest scientific precision. As a hygrometer, "Mason's wet-and-dry-bulb" instrument leaves nothing to be desired.

The one special precaution of a meteorological character to be taken in connection with all astronomical observations, whether made in an observatory or in the open air, is that equality of temperature should be secured everywhere. Whilst the due ventilation of the observatory should at all times be provided for, it is absolutely essential, in order to insure good results with every kind of instrument, that all doors and windows should be thrown open, so as to obtain a free current of air everywhere for fully half an hour before observations are to be begun; in hot summer weather, indeed, a longer time will generally be found necessary. The object of these precautions is obvious enough: it is to insure the inside air and the metal of the instruments being cooled down (or, as it may sometimes happen, being warmed up) to the temperature of the external air. In order to learn whether this equality exists, every observatory should have a thermometer outside as well as inside. The former should be hung on the north side, away from the sun, and, if possible, not actually in contact with the observatory itself. G. F. CHAMBERS

(*To be continued.*)

NOTES

WE learn with much pleasure from *Science* the election of Prof. E. S. Holden to be President of the University of California, and Director of the Lick Observatory. Prof. Holden's resignation as Director of the Washburn Observatory at Madison, Wis., takes effect on January 1 next. His appointment as Director of the Lick Observatory will hardly be a matter of surprise to those who are aware that, as consulting astronomer, he has virtually had the direction of the work as it has progressed, visiting the site on Mount Hamilton in 1881, and again in 1883 and 1884. Very happily the choice both of the Lick trustees and of the regents of the University has fallen upon Prof. Holden. It is understood that, in his letter of resignation to the regents of the University of Wisconsin, he strongly urges the name of Prof. W. A. Rogers, of Harvard College Observatory, as his successor.

THE wealthy American, Senator Stanford, proposes to establish a Californian University. He intends to give to it, besides estates worth 5,300,000 dollars, a donation in money increasing its endowments to 20,000,000 dollars. The University will be located at Palo-Alto, thirty miles from San Francisco, and is apparently to be modelled somewhat after the plan of the Johns Hopkins institution.

THE prospectus has been issued by Herr Fischer, publisher, of Jena, of a new scientific periodal entitled *Zoologische Jarhbücher: Zeitschrift für Systematik Geographie und Biologie der Thiere*, which is to be brought out under the editorship of Dr. J. W. Sprengel, of Bremen. Notwithstanding the vast number of scientific journals, both author and publisher think that this department of science does not receive the attention which it deserves. It is not excluded, they say, from scientific periodicals; but communications relating to it appear more or less as strangers by the side of others. The new periodical will be wholly devoted to this class of subjects. In the first section the papers will, for the most part, be of a higher kind than the mere description of new species, except those for which no special journal exists. The geographical section will contain studies on the distribution of all kinds of animal and vegetable life, and special attention is promised to the biological section. Contributions will be received in German, French, English, and Latin. The periodical will appear quarterly, each four issues making a volume.

THE success of the last electrical exhibition at the Paris Observatory was so complete that the International Society of Electricians is preparing another for next spring.

A GENERAL meeting of members of the French Association for the Advancement of Science has been summoned to approve of the fusion with the Société Française. Lectures and meetings will take place this year under the patronage of the united societies as a single body.

THE well-known electrician, Dr. James Moser, who was working for some time at Prof. Guthrie's laboratory, has been appointed as *privatdocent* at Vienna University.

THE Colonial fisheries are to form a prominent feature at the Indian and Colonial Exhibition which is to be held next year. The Aquarium will be considerably enlarged, and special tanks are now being prepared for the reception of the various fish from the Colonies. A tank of colossal proportions is to be allotted for the purpose of exhibiting turtles in large numbers which will be despatched from India together with other specimens in the early part of next year. We do not yet know what fish are to be forwarded from the various colonies, but the utmost care will have to be exercised and the most perfect arrangements made in order to provide for their various necessities. The collection promises to be one of great interest and value, although its success all depends upon how the fish withstand the long journeys to which they will be subjected.

TOWARDS the end of October the remarkable sun-glows were again seen at Stockholm. In the western horizon a yellow cloud-bank, strongly illuminated, appeared behind a number of tiny clouds, greyish in colour, the sky above the former, to a height of about 45°, being lurid, entirely colouring the clouds. Later on in the evening the glow imparted to the edges of the clouds the most remarkable reflections of colour, varying from ochre to yellow, violet, and pink, with shadings of blue. At times the higher-lying clouds formed most remarkable formations. It seemed that the glow was situated between cumulus and cirrus clouds.

ON October 21, at about 5 a.m., a brilliant meteor was observed at Skaadö, on the south-east coast of Norway. It appeared first near the zenith, and describing a circle of about 70°, disappeared in the south-west, about 20° above the horizon. In spite of the sky being covered with clouds, and its being still dark, the country around was lit up as in daylight, objects being clearly discernible at a great distance. As no sound or explosion was heard, it is assumed that the track of the meteor lay in the upper parts of the atmosphere.

SOME Thames trout are being spawned at Sunbury by the Thames Angling Preservation Society, who are doing their utmost to replenish the stock of this fine species of Salmonidæ, which, unhappily, have now become a rarity. The ova will be incubated by the National Fish Culture Association, and the fry will ultimately be deposited in one of the Thames nurseries.

THE Catalogue of the Library of the Royal Society of Tasmania is a considerable volume; and it is a matter of some surprise to find that men of science in this distant colony have

such an excellent library as this. It embraces every class of literature, and appears especially rich in periodicals, and in works relating to Australasia.

THE last "Circular" of the Johns Hopkins University Library contains a list of the periodicals, including the scientific and literary publications of various societies, regularly received. Although newspapers and official reports are omitted, the list extends over eleven closely-printed columns, and probably contains the name of every periodical in the world in any way connected with science.

AN interesting bi-monthly periodical has just made its appearance in Colombo. It is entitled the *Taprobanian; a Dravidian Journal of Oriental Studies in and around Ceylon in Natural History, Archæology, Philology, History, &c.*," and is edited by Mr. Nevill, F.Z.S., of the Ceylon Civil Service. The first number contains various notes and queries, relating mainly to scientific subjects, and articles on Tamil inscriptions in Ceylon, comments on Ptolemy's geography, on Ceylonese inscriptions in the Asokha dialect, archæological reports on Ceylon (No. 1), and on the Vaedda dialect. The whole of the contents of the thirty-two pages of the first issue is from the pen of the editor, who hopes to make his periodical a storehouse of details, available hereafter for the elaboration of any special subject connected with the Tamil and other Dravidian races. He promises to do his utmost to procure for investigators in Europe, America, or elsewhere, any local information of scientific interest that they may seek. We hope the venture will have the success which the editor's learning and enterprise so well deserve.

WE are glad to notice the re-appearance of the *Orientalist*, another Ceylon periodical, containing articles of much scientific interest, and which has been noticed in NATURE. It ceased publication for some months, but the editor is now publishing double numbers to make up for lost time, which, it is only fair to add, was due to negligence of subscribers, not to that of its learned editor.

THE present number (x. No. 23) of *Excursions et Reconnaissances* of French Cochin China contains the fourth part of M. Landes's article on Annamite tales and legends; but it is mainly occupied with the continuation of M. Tirant's long account of the fishes of Lower Cochin China and Cambodia.

THE inhabitants of Srinagar, Cashmere, have again been thrown into a state of alarm and consternation at the recurrence of earthquake shocks there. The first shock—a severe one—was felt on the night of the 15th inst., and this has been followed by a constant series of slighter ones.

THE last number of *La Nuova Scienza* contains instructive papers on "Modern Italian Thought," on "Cosmic Evolution," and on the "German Pessimist Philosophy." The first of these papers deals with Prof. G. Sergi's "Origin of Psychic Phenomena" (Milan, 1885), which forms the fortieth volume of the Italian "International Scientific Library," and which contains a useful summary of the arguments of physiologists and psychologists on the genesis and nature of psychic force. Sergi contends that psychis is merely a function, or rather an implement of the body, analagous to the teeth, claws, and other offensive and defensive members. Against this materialistic conception Prof. Caporali, author of the paper in question, and editor of *La Nuova Scienza*, contends that pscyhis is inherent in all forms of matter, from the atom to the highest organisms, and that it is the cause, not the effect, of motion, that is, of all progress and evolution. It is an error to suppose that the organ originates the psychic function, for the function precedes the organ. The lowest organisms, such as the amœbæ, have no differentiated organs, yet they exercise psychic functions, as shown by O. Zacharia in his new work on "Organismen ohne Organe" (1885). Hence, to regard psychis as a mere function of the body, and introduce it later into the fully-developed nervous system as the product of the system, is neither philosophic nor scientific. The article on the German Pessimist school contains biographical notices and short summaries of the teachings of Schopenhauer, Von Hartmann, Geiger, Noiré, and other exponents of that philosophy. The *Nuova Scienza*, which continues to be conducted with remarkable learning and ability, deserves more general recognition than it appears to have yet received in this country.

TELEGRAPHS are extending with extraordinary rapidity over Southern China. At the present moment Pekin in the far north is connected by a direct line through Canton with Lungchow on the frontier of Tonquin, the extension from Canton to the latter place being made during the recent war, purely for military purposes. Thus we have one great line stretching through the Chinese Empire from north to south, and at the present moment an important line is being constructed along the southern borders of China through the provinces of Kwangtung, Kwangsi, and Yunnan. Starting from Nanking in Kwangsi, where it joins the Canton-Lungchow line, it will extend for nearly 600 miles to Mung-lih in South Yunnan, running for half the distance along the Yukiang, the name of the Canton river in its upper course. The work is being carried out by the Chinese themselves with the assistance of one European, and it is stated that during the recent war the Canton authorities equipped a complete field telegraph staff, the members of which were so thoroughly trained that they have been able to put up 35 miles of line in a single day for war purposes. Telegraphs have now secured a firm footing in China, and their extension over the whole country is a matter of time only, aided perhaps by political events. In the great movement towards a centralised Government now progressing in China the telegraph line will play a vital part, for it will utterly destroy the semi-independence of the provincial viceroys, hitherto secure in their remoteness from the seat of government.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus* ♀) from West Africa, presented by Miss Hodgson; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mrs. Berens; an Arabian Gazelle (*Gazella arabica* ♀) from Arabia, presented by Mr. John Patton; two Short-headed Phalangers (*Belideus breviceps* ♀ ♀) from Australia, presented by Mr. P. S. Abrahams, F.Z.S.; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Mrs. Morgan; two Indian Cobras (*Naia tripudians*) from India, presented by Mr. W. G. Burrows; two European Tree Frogs (*Hyla arborea*), European, presented by Mrs. A. Bratton; two Catfish (*Amiurus catus*) from North America, presented by the National Fish Culture Association; two Mule Deer (*Cariacus macrotis* ♀ ♀) from North America, a Triton Cockatoo (*Cacatua triton*) from New Guinea, deposited; two Barbary Wild Sheep (*Ovis tragelaphus* ♂ ♀) from North Africa, four Spotted-billed Ducks (*Anas pœcilorhyncha* ♂ ♂ ♀ ♀) from India, purchased; a Sambur Deer (*Cervus aristotelis* ♀), born in the Gardens.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, NOVEMBER 22–28

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on November 22

Sun rises, 7h. 33m.; souths, 11h. 46m. 22·9s.; sets, 16h. 0m.; decl. on meridian, 20° 15′ S.: Sidereal Time at Sunset, 20h. 7m.

Moon (at Full) rises, 16h. 43m.; souths, 0h. 25m.*; sets, 8h. 14m.*; decl. on meridian, 17° 1′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	9 32	13 9	16 46	25 32 S.
Venus	11 28	15 8	18 48	25 13 S.
Mars	23 31*	6 31	13 31	10 54 N.
Jupiter	1 53	8 0	14 7	0 40 N.
Saturn	18 19*	2 27	10 35	22 21 N.

* Indicates that the rising is that of the preceding and the southing and setting those of the following day.

Occultations of Stars by the Moon

Nov.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
22	θ^1 Tauri	4½	18 29	19 17	33 272
22	θ^2 Tauri	4½	18 38	19 9	6 299
22	75 Tauri	6	18 49	19 8	133 172
22	B.A.C. 1391	5	19 18	20 17	60 246
22	Aldebaran	1	21 48	22 57	75 257
23	117 Tauri	6	17 59	18 42	29 271
24	130 Tauri	6	2 52	3 58	92 323
24	26 Geminorum	5½	22 59	0 6†	54 241
26	1 Cancri	6	5 40	6 46	107 292

† Occurs on the following day.

For further particulars in regard to the occultation of Aldebaran see NATURE, vol. xxxii. p. 610.

Phenomena of Jupiter's Satellites

Nov.	h. m.		Nov.	h. m.	
22	3 42	I. tr. egr.	26	4 19	II. occ. reap.
23	6 43	III. ecl. disap.	27	4 2	III. tr. egr.
24	7 18	II. tr. ing.	28	5 9	I. ecl. disap.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Nov.	h.	
24	23	Saturn in conjunction with and 3° 59′ north of the Moon.

A special watch should be kept on November 27 and the days immediately preceding and following, in order to note whether there is any recurrence of the meteoric shower observed on November 27, 1872, and believed to be connected with Biela's comet. The radiant point is near γ Andromedæ.

CHEMICAL NOTES

IN order to obtain constant temperatures easily maintained and completely under control, Messrs. Ramsay and Young (*C. S. Journal, Trans.*, 1885, 640) employ vapours of the following compounds, and alter the pressure to which each vapour is subjected: carbon disulphide, ethyl alcohol, chlorobenzene, bromobenzene, aniline, methyl salicylate, bromonaphthalene, and mercury. By the use of the vapours of these bodies at various pressures, any desired temperature between that of the atmosphere and 360° can be easily obtained. The authors have very carefully determined the vapour-pressures of these compounds for a large range of temperature. The methods of experiment are fully described, and the results are presented in the form of tables, which must prove of much service to those chemists and physicists who have occasion to raise pieces of apparatus to a known temperature, to vary that temperature if required, or to keep it perfectly constant for an indefinite period.

As was noticed in these columns some time ago, Dixon has recently proved that a mixture of perfectly dry carbon monoxide and oxygen is not exploded by the passage of electric sparks; but that the presence of a minute quantity of water suffices to determine the combination of the gases. Dixon supposed that the action of the water was as represented in the following two equations:—

$$(1)\ CO + H_2O = CO_2 + H_2,$$
$$(2)\ 2H_2 + O_2 = 2H_2O.$$

Now Traube (*Ber.* 18, 1890) has shown that carbon monoxide does not decompose water in complete absence of air or oxygen, even at very high temperatures; he has also shown that when moist carbon monoxide and oxygen are exploded together, hydrogen peroxide is an invariable product. Traube suggests that the following three changes probably occur during the explosion in question:—

$$(1)\ CO + 2H_2O + O_2 = CO(OH)_2 + H_2O_2.$$
$$(2)\ CO + H_2O_2 = CO(OH)_2.$$
$$(3)\ 2CO(OH)_2 = 2CO_2 + 2H_2O.$$

When hydrogen is burnt in moist oxygen, hydrogen peroxide is always produced, according to Traube. Whether a perfectly dry mixture of hydrogen and oxygen could or could not be exploded by electric sparks cannot be regarded as settled; Traube thinks that such a mixture would prove to be non-explosible. He regards the mutual action of hydrogen, oxygen and water as in all respects comparable with that of carbon monoxide, oxygen, and water, or with that of zinc, lead, and some other metals, oxygen, and water. The changes which occur in the explosion of moist hydrogen and oxygen are formulated by Traube thus:—

$$(1)\ H_2 + 2H_2O + O_2 = 2H_2O + H_2O_2.$$
$$(2)\ H_2O_2 + H_2 = 2H_2O.$$

The occurrence of the second part of this reaction has been experimentally demonstrated by Traube.

IN continuing his experiments on nitrification, Warington (*C.S. Journal, Trans.* 1885, 758) has shown that the limit of concentration (about 12 per cent.) beyond which urine ceases to be nitrifiable under ordinary conditions may be largely extended by adding gypsum to the liquid. A solution containing 50 per cent. of urine, and 22 milligrams of gypsum for every c.c. of urine, began to nitrify after about five months; solutions containing 15, 20, and 30 per cent. of urine began to nitrify after the lapse of 53, 68, and 78 days respectively. The gypsum prevents the accumulation of ammonium carbonate in the liquid.

J. H. VAN'T HOFF describes (*Berichte*, xviii. 2088) experiments on phenomena, analogous to those exhibited by gases at their "critical points," occurring during chemical decomposition. Phosphonium chloride, PH_4Cl, which melts at 25°, was heated to 50°-51° at a pressure of 80-90 atmospheres in a Cailletet's apparatus; under these conditions the line of separation between liquid and vapour disappeared, and, on cooling, the formation of nebulous streaks became plainly visible. It is well known that the vapour obtained by heating PH_4Cl under ordinary conditions consists of PH_3 + HCl; it is not possible to say to what extent the melted substance in van't Hoff's experiment consisted of a compound of PH_3 and HCl, and the gaseous part consisted of a mixture of these constituents, yet it seems certain that, when PH_4Cl, a compound which is chemically decomposed when vaporised, is heated to 50° under a pressure of 80-90 atmospheres, there exists identity between the vapour and the condensed portion of the body.

LA COSTE describes (*Berichte*, xviii. 2122) a modification of V. Meyer's apparatus whereby the densities of easily decomposed compounds may be determined at low temperatures under small pressures.

GEOGRAPHICAL NOTES

A CATALOGUE of the printed maps, plans, and charts in the British Museum has been prepared by Prof. Douglas, and will be issued in two large volumes. It represents the contents of the manuscript catalogue in 323 volumes, the catalogue of the maps and plans in the Royal Library in two printed volumes, and the manuscript catalogue of charts in the same library. The original manuscript catalogue was made under the superintendence of Mr. Major, late Keeper of the Department of Maps. The orthography adopted in the present catalogue is that used in Keith Johnston's "General Dictionary of Geography," with the exception of India, for which Hunter's "Gazetteer" has been taken as a guide. The utility of this catalogue to the geographical student will be found in the comparatively simple alphabetical arrangements for the headings of countries and places, combined with the names of geographical writers, which last often serve as short cuts to any particular atlas or map. Thus, under the head of "Ptolemy," the pillar and foundation of ancient geography, there are seventy-four entries referring to the various editions and copies of his "Geographica." Turning to the names of the fathers of modern geography, Ortelius and Mercator, we find under the former twenty-nine entries describing the various copies and editions of his "Theatrum orbis Terrarum." The geographical labours of his contemporary and friend, Mercator, will be best realised by a reference to the

heading "World: Atlas: Modern," p. 4491, where will be found probably the most complete list of Mercator's atlases extant, ranging from 1495 to 1636.

AT the meeting of the Geographical Society of Paris on the 6th instant, M. Germain, who presided, pronounced a eulogium on Milne-Edwards. M. Duveyrier called attention to a report addressed to the Spanish Government by Capt. Bonelli, relative to the Spanish possessions on the West Coast of Africa, according to which it appeared that the writer claimed on behalf of Spain nearly a hundred kilometres of the coast belonging to the French in Senegal. A letter was read describing the departure from Buenos Ayres of M. Thouar on a new expedition to complete his work on the Pilcomayo. A note was read from M. Venukoff on the recent incidents of Russian geographical exploration. M. Chaffaujon described his late explorations in the basin of the Orinoco, to which we have already made frequent reference.

THE current number of *Petermann's Mittheilungen* has for its first article a lengthy communication by Dr. Theodor Fischer on the development of coasts. His conclusion is as follows:—Wherever the sea by breakers and currents has exercised a preponderating influence on the form and development of coasts, whether flat or precipitous, the line of coast takes the form of a succession of arcs, in the case of steep coasts with a short, and of flat coasts with a long, radius; where the coasts exhibit other features than these, although the action of the sea be not wholly excluded, yet other causes, especially tectonic alterations in the surface and movements of the earth's crust, are more powerful or are very recent. Herr Langhaus gives a map of the Cameroon Mountains, with an accompanying description, containing a short sketch of recent exploration in the region. Dr. Boas writes on the topography of Hudson's Bay and Hudson's Straits, with a map; and Herr Wichmann describes the new republic in South Africa, also with a small but remarkably clear map by Dr. Havernick. The usual geographical and critical notes and lists conclude the number.

M. EUGÈNE AUBERT has been charged by the Ministry of Public Instruction with a scientific mission to the basin of the Amazon.

BEES AND OTHER HOARDING INSECTS[1]

Their Specialisation into Females, Males, and Workers

IN discussing the differentiation of bees into females, males, and workers, I shall have no need to call your attention to any new discoveries in the world of wonders among those minute creatures that we have had with us for all ages, and whose life we are just now beginning faintly to understand. My illustrations will be drawn mainly from other orders, in which it will be impossible for me to make a mistake without its being readily seen by some of the general public as well as the specialists.

The limits of this paper will not permit elaborate definitions, or fine discriminations, and I have therefore to ask that you will kindly make your own definitions, taking care to give to my words in general the narrowest sense compatible with the use to which I apply them.

From the creatures and the plants, that man has domesticated for his use, we have learned nearly all of the lessons in heredity, which we have no good reason to unlearn, and my first illustration shall be from one of these, the barn yard fowl.

If we mate a Black Spanish fowl with a Buff Cochin, and hatch out the eggs as the bees do theirs, in an incubator, till we have a hundred chicks, among these we shall find a very great diversity. Some when fully grown will be nearly, if not quite, as heavy as the Buff Cochin, and some will weigh little, if any, more than the Black Spanish. Their respective weights will probably vary between those natural to their sex in the two varieties to which their progenitors belong, but much the larger number will be very nearly half way between. And as colour is not necessarily correlated with weight, it is quite possible that the heaviest chick will be the blackest; that is to say, that he may take his colour almost entirely from one parent, and his weight and form from the other. In colour every one of the hundred chicks will, when fully grown, be in some degree distinguished from every other; and if we take colour, size and form together for our guide, there will not be one among the whole number that we cannot readily distinguish from every other. Now this particular cross from the great difference in size, form and colour of the parent stock enables us to see very clearly a fact which the closest and most careful investigation shows to be a general law. It is this:

All offspring are variable by heredity. And under some circumstances the variations are wide.

Nearly every youth, who has amused himself with an aquarium, knows that he can dwarf his fish if he chooses to do so. Other things being equal, the weight of a fish depends upon the amount of food it is allowed to consume. This variability is so great among fishes, that of two as nearly alike as possible, either one may be fed so that he shall exceed a pound in weight, before the other, receiving very little food, shall turn the scale at an ounce.

Thus insufficiency of food affects the development of all organs. All breeders of animals have some knowledge of this fact as applied to their own business, and of which our fish merely affords a striking example. It is an inevitable deduction, that when the food is of the general quality which is suitable for the due nourishment of all the organs but is insufficient in amount, the stronger organs, if such there be, will take more than their share, and the weaker organs will go to the wall. From this matter of food supply we have a general law, which may be stated as follows:

Living creatures are variable from the amount and quality of their food. And among some orders the limits of this variation are wide.

It is scarcely necessary for me to go into the fact that the insects, being exposed to more extreme vicissitudes than the larger orders of animal life, are much more variable in almost every respect. It will be interesting, however, and it may be instructive in the line of our inquiry, to point out some powers of variation in sex in a very common plant, which, while they are very much greater than those of the bee, have some points of striking resemblance.

Indian corn is pictured to the unobserving mind as a plant bearing something good to eat at the side and a tassle on the top. The botanist tells us that the tassle on the top is a male plant, that at the side is a female plant or perhaps more than one, that all these are joined upon one stalk, and that the something good to eat is the product of the female plant, fertilized by the pollen of the male. All this is fact as far as it goes; but it gives us no conception of the whole truth.

On going into the field in bloom we find that nearly all of the stalks have tassels on the top; they are male plants. In a good field we shall find perhaps half of them with reproductive females at the side, say two good ears of corn to a hill. There are, therefore, nearly twice as many perfect males as there are of perfect females. We find also that the undeveloped females are very numerous—from one to half a dozen on a stalk. And a close examination shows that the number of females that become developed is almost entirely a matter of food. Such an investigation shows also some plants bearing only a female on the stalk and some that are entirely undeveloped in both sexes.

Thus in our field of Indian corn we have male stalks, male and female stalks, female stalks, neuter stalks. And the stalks that bear developed male and developed female individuals all have (*a*) a male individual on the top, (*b*) one, two, or three females at the side, (*c*) one to six undeveloped females at the side, and possibly with, possibly instead of these (*c*) they may have (*d*) one to half a dozen buds and germs of females at the side.

If, when the corn is ripe, we go with the farmer and gather a basketful, we shall invariably find that on each ear there are kernels less perfectly developed than others, and we shall have every reason to believe that in the basketful there are some kernels that could not reproduce, that some kernels would reproduce but would, under the most favourable circumstances, give but imperfect offspring, and that there would be a very wide range in the degrees of the imperfection of the plants produced from these imperfect kernels.

As a matter of fact, the farmer in planting, selects with care the most perfect ears, and the most perfect parts only of the ears so selected, and yet we have the males, the females, and the neuters or the undeveloped for the result as I have described them.

Indian corn is so extremely variable in this matter of sex, that careful experimenting in this direction would be likely to give most interesting results in a single lifetime.

[1] Read before the Brooklyn Entomological Society, December 29, 1884, by Edwin A. Curley.

Having now illustrated some principles of variability, and given some idea of the extent to which it may go, under our own observation, we must deal with the question before us by way of hypothesis.

Let us suppose a primitive or typical Bee among the honey-seeking insects of early days. She is necessarily a creature having such attributes as are common to all species of bees which are her offspring, but in many respects she is very unlike our Hive Bee of to-day. We see her at a time when this typical species has already learned the wonderful lesson of thrift. She stores honey in times of plenty to provide for times of want. She is feeding her offspring from her stores. As the keen competition of life goes on, she must provide for the wants of her offspring for an ever-increasing period, and, as her powers in this respect are taxed to the utmost, her powers of reproduction are of necessity diminished; she produces some imperfect eggs, and she produces fewer eggs. Still, the vast majority of her offspring perish, either for lack of sufficient food or as prey to natural enemies before their power of self-defence are sufficiently developed for successful flight or resistance.

It is quite reasonable to suppose that the bee has been subjected to such vicissitudes as these. The extraordinary differences in the sizes of the various living species of bees would indicate the truth of the theory of insufficient food as far as we have yet followed it. If we have a species of bee only one-eighth of an inch in length while some others are an inch and a quarter in length and stout in proportion, it will take one thousand (1000) of these Lilliputian bees to weigh as much as a single specimen of one of these largest species. Is it not most reasonable to suppose that this tremendous variation in size is chiefly due to the matter of food supply, as is the well-known fact in the very large variation we can thus make in the size of an individual fish?

Now when the food supply is so very scant that the size of the offspring is necessarily much dwarfed, evidently the weakest will die in the process of rearing; evidently also the mother-bee whose reproductive powers are the weakest as to the number of offspring, and whose maternal instincts are the strongest, that is to say, the one that lays the fewest eggs and takes the best care of her young, will best succeed.

If any broods of young perish altogether from famine, it will be those that are so numerous as entirely to overtax the powers of the mother-bee in feeding them. Thus we gradually approach a time when the care of the mother-bee extends to a period in the life of the offspring when they appreciate and respond to her affection. The offspring are still numerous and the struggle for existence is severe. The food supply is sufficient to bring the young to that point in existence when they are capable of applying with some prospect of success the instinct, that is to say, the congenital knowledge, inherited from the mother. And as the mother-bee continues after this period to help them in their struggle for existence, they see and understand her assistance, and they necessarily respond to her affection. Here is definitely established filial love, in response to maternal affection, and it is necessary that this filial love should be established in strength even in this little insect before it is possible that the specialization under consideration shall commence. It must not be supposed that the size of these tiny creatures renders them incapable of this strong feeling—we must in this respect as in others go by the evidence of our senses and the necessities of the case. Without strong affection the whole life of these bees is quite inexplicable, while with it their conduct is the natural outcome of a certain amount of intelligence applied to certain conditions of existence.

Among all creatures nursed with a mother's care, filial love grows stronger and stronger according to the capacity and circumstances of the offspring and the strength of that affection which calls it forth. But when the time for mating approaches the young seek other relationships and so far as it is incompatible with these does filial love decay.

But what happens if the young are by nature incapacitated for these other relationships?

Then filial love necessarily grows with the individual and strengthens with her strength.

The mating instinct may be almost or wholly lacking; and, if wholly lacking, then all of that part of the highly nervous organization inherited from the mother that is devoted to the affections will have no other outlet than in filial love.

The common life around us, and man himself will perhaps afford us some partial illustrations of this necessary law. The best illustration outside of the insect world is one of which the facts may be easily ascertained by any person who will make the inquiry.

The breeding of mules is an important industry. The horse and the ass are capable of strong affection, but their colts seldom develope a filial love which has a controlling influence on their adult life.

But the mule, the hybrid between the male ass and the female horse, except in very rare instances, is congenitally incapable of reproducing its kind. It has more or less of the instinct for mating, but it necessarily does not have the strong sexual passion of a perfect equine animal. Its love for its mother however amounts to a master passion; it is not spasmodical, but it is intense and it continues as long as there is an opportunity of showing it. It is capable of transfer to another object and those who breed mules in large numbers take a useful, instructive, and amusing advantage of this fact.

When the young mules are weaned, the mothers are withdrawn from their company, and one, otherwise worthless old mare is substituted for many mothers. The poor young things turn to the good-natured old mare as to a very goddess; while she receives their worship with the equanimity of her sex, never hinting in the mildest terms that it is an idolatry that should be abated. As the dilapidated goddess herself may be depended upon for her staid qualities, it follows that her worshippers are thereby kept out of mischief. And the poor mule is not a backslider, it is always a consistent worshipper.

I have stated that filial love is absolutely necessary to the specialisation under consideration. It should be added that it must be intense in its character and capable of replacing to a large extent the maternal instinct of the perfect creature.

From the fact that insufficiency of food would affect the growth of all organs we deduce the further fact that it would affect weak organs the most, giving those not congenitally perfect an irregular development. It follows also that if a very young animal congenitally perfect, receives for a long period only sufficient food to sustain life, the organs not vital will be more or less dwarfed in their proportions, as compared to the vital organs.

For here the law of parsimony is absolute. The vital organs *must* receive a certain supply, or the life perishes. The non-vital organs make no such imperative demand, and they consequently get less in proportion. And an organ that is entirely useless to the life of the individual, would under such circumstances receive no nourishment whatever; excepting only as it is correlated to the organs that are useful or vital. The reproductive organs of the young of all species are entirely useless to the life of the individual; their powers are latent, and, excepting as they are correlated to other organs, they make no demand for nourishment. Starvation must therefore dwarf the reproductive organs of very young individuals, in proportion to those which are very important, or absolutely necessary to life. In plants this fact is constantly shown all around us and our maize is a striking example.

The reproductive powers of swine are very great. But a young pig that is half-starved will not only have its reproductive powers very much retarded in their growth, it will have them diminished in their ultimate strength. This is a matter in which general observation furnishes the proof. I have not asked fish-culturists the question but I am absolutely certain that, other things being equal, the number of fish-eggs will depend upon the size and thrift of the individual, and these, other things being equal, depend upon the question of food.

It is easy to imagine a possible case among the vertebrates or even the mammals in which a perfectly normal organism by long continued insufficiency of food, is allowed a slow development of those organs that are absolutely necessary for its life, and of the others most nearly correlated to these, while the organs of reproduction, in the incipient or undeveloped stage in which they were when starvation commenced, still remain till they become fixed and immutable, notwithstanding any abundance of food that may be given at a later period of life.

Let us now go back to the variability of eggs as shown by our hundred chicks or the variability of seeds as shown by our ears of corn. This variability is variability of the germs, and this is congenital variability. This variability as shown in the hundred chicks gives us from three to six pounds for their adult weight and they all differ in colour, form, or both.

We take no account at present of the fact that our primitive bee as shown by her offspring of to-day was far more variable

than fowls, but we note that she was a hoarding insect, gathering with great care and industry in good times food for times of scarcity; that she supplied her young from her stores; and that they responded to her maternal cares with filial affection.

We left her at a time when the struggle for existence was keen and some of her offspring starved through no fault of her own. She was exhausted with a constant search for food and the cares of a numerous and starving family.

This necessarily involved the fact that her reproductive system was quite out of balance, she was incapable of producing as many eggs as her progenitors, and many of those that she did produce were imperfect.

Of these imperfect eggs some addled and some hatched out imperfect offspring.

At this point we proceed to inquire into the nature of the imperfections of the offspring.

There would probably be quite a variety in these defects. One might be wanting in legs, another deficient in wings, another insane, another deaf, another possibly congenitally blind, or perhaps wanting in that sense, whatever it is, by which ants and bees intelligently converse with their fellows.

All of these and many other congenital defects are possible and even probable, because we see them in other and the least changeable orders and species of creatures.

But the greatest in number of all the very important defects would be defects of the reproductive organs; because they are the organs in the mother which have been most affected by her unfortunate environment.

Under these circumstances, what must become of all the imperfect offspring in a sharp struggle for existence?

Manifestly all wanting in legs, or wings, or eyes, or in any organs necessary for quick and intelligent movements in attacking or resisting enemies, or in collecting food, must die at an early age, notwithstanding any possible care of the mother.

Manifestly none of those defective in the reproductive organs would so die, unless they were also defective in some other particular, unless indeed the struggle became so keen that perfect and imperfect went to the wall together.

Manifestly also these insects thus congenitally imperfect in the reproductive organs would have a great advantage over all others in the struggle for existence, *from the time at which the reproductive period in those others commenced.*

If altogether incapable of reproduction, they would have vitality enough for themselves and a surplus to expend.

The energy inherited from the hardworking progenitors would be too great for idleness. The surplus must be expended at the dictates of love or hate. Hate, beyond that healthy indignation at attack or imposition which is necessary to self-protection, is unnatural to such beings.[1] But they have one to love, and that is the mother. The perfect offspring depart to reproduce their kind, and the one, two, three, or the dozen of the imperfect ones, stay behind with the mother bee, or if she dies they transfer their affection to some one of their perfect sisters.

Now another hoard of honey must be gathered, and another lot of eggs laid, hatched out and cared for. The female bee works industriously and, true to her instinct, denies herself of necessary food that she may lay by the more for her future offspring.

And now these creatures, happy in their deprivation, capable of supplying their own wants with ease, insist on gathering food for the mother-bee. She takes it with eagerness, tastes and stores it away. And after the young are hatched out, the like attempt to feed the mother-bee results in feeding them. Thus this family have for a time a great advantage in the struggle for existence and there is a perfectly adequate motive for the conduct of the kind little creatures who minister to the wants of the mother-bee.

Still this happy family is not precisely the foundation of our modern bee-hive; it is really too affluent for complete success.

The mother-bee, no longer overworked, recovers her health and unfortunately lays perfect eggs; with the help of the nursemaids she rears her young without overtaxing her powers. Her family and any others like it have very decided advantages over the old type, to which nevertheless they inevitably revert, to fall into a state of starvation as before; for, in this family, the nursemaids have, and can have, no probable successors while there is plenty to eat.

If this happens to one family of bees, it will probably happen to many families. The temporary affluence of one family caused by the presence of the helpers will itself increase the depth of poverty in the neighbouring families, and this poverty will give them helpers in undeveloped bees in the next generation, by which in turn they will be raised to affluence. Thus there will be alternating generations of bees—that is to say, generations with helpers, followed by generations without them.

Among those that go forth from the mother-nest to find mates and rear families of their own are some that are congenitally weak in the reproductive organs. The majority of these meet with sound mates and the variation dies out. But some individuals thus congenitally imperfect meet with like mates. The congenital weakness of the reproductive organs is intensified in the offspring. The majority are perhaps so imperfect as not to be able to reproduce their kind. Any of these that reach maturity will be glad helpers of the mother-bee.

Their less imperfect brothers and sisters are defective in many degrees. The offspring of one never reach maturity. Those of another nearly all thrive and there are a dozen reproductive females among them.

In their migrations at swarming time these bees sometimes become established near less affluent families, congenitally perfect, and are sometimes crossed with them.

Here we have the bees in a condition of the greatest variability as to reproductive powers, but all of those that are getting on well in the world have among their offspring some that cannot reproduce, and helpers are consequently numerous.

About this time the paupers are established as a distinct variety. Sick and discouraged with the unsuccessful battle of life, they are more or less tolerated in the affluent families of their neighbours. But when they have recovered their bodily strength, they have not also regained their mental balance. They have become accustomed to a life of tolerated dependence; so they live in the nest and lay eggs to be reared by their industrious neighbours. Sometimes the imposition becomes too great for good nature to stand and there may be a terrible slaughter of the innocent paupers and their offspring. The ones however that most nearly resemble the useful members of the community escape destruction and thus are established the Cuckoo-Bees, their simulation of virtue being ever the closer as indignation increases at their vice.

The varieties become extremely numerous; many of them however becoming rapidly extinct. At first in all families where there are helpers there are almost or perhaps quite as many undeveloped males; but this being for bees a hurtful variation the tendency of natural selection is to their diminution. On the whole those families are the most successful in which there are the largest number of undeveloped females.

All this time experience is being gathered in the mothers and differentiated and stored in their systems, to re-appear as instinct and intelligence in the offspring.

Sometimes the most affluent families come to want, and perfect females are dwarfed in their reproductive organs by scarcity of food and are only capable of being helpers.

From all this diversity there is at last a type evolved which is on the whole the best for the majority of the bees. This type is one involving a degree of imperfection in the reproductive organs of all offspring unless highly stimulating food in large quantity is supplied from a very early stage of growth. Thus the normal product is simply a helper and the number of males and females in proportion to the number of helpers and the food supply is a matter entirely under the control, not of chance nor of the mother, but of the community. This then, I think, is the foundation of the Hive-Bee family, the highest type of the flying Hymenoptera.

As instinct enlarges and intelligence increases, the helpers take more and more upon themselves the care of the household. They become pre-eminently the workers, and their officious interference is continually stopping the mother-bee's toil, and stuffing her with the best food they can obtain. She gives herself up more and more exclusively to the work of reproduction, and her powers increase till she becomes capable of changing food into eggs and individually starting a hundred thousand existences in her single lifetime.

Between this highest type of the bee and the lowest, we find several hundred varieties all capable of explanation, either as progressive or retrogressive developments from our primitive bee. Many of them are highly specialised in their social habits, and it seems to me that all those that have two fully developed sexes and one or more undeveloped sexes, must necessarily have

[1] Lubbock's instances of ants attacking strangers and not rescuing friends by no means demonstrates the opposite of this proposition.

thrift, intelligence and filial love as the foundation without which it is impossible that such creatures should of themselves build up such a singular condition.

It seems to me that hunger, something approaching starvation, is necessary as a beginning of the specialisation. Now we all know that from their capacity to increase with enormous rapidity some insects are subject to great vicissitudes in the matter of food. The locusts, for instance, increase in numbers till, having eaten everything in their native habitat, they leave it in dense masses that obscure the heavens and which devastate vast regions. Of the next brood, immensely more vast in numbers than even these, comparatively a small remnant reach maturity, and scarcely any reproduce their kind. The race grows up again from the few starved individuals too weak to leave the old habitat and of which a few manage to survive long enough to lay some eggs. Those doubtless produce many imperfect insects, but these specialisations are not useful to the race in this case, and they cannot survive. I think it likely, however, that man could specialise locusts and many other insects in this way without difficulty. I think it likely that he could with great care so specialise fish and possibly fowls and with great patience and much difficulty some of the mammals. I think also that if mules were from a thrifty hoarding stock like squirrels they would be in the habit of feeding the old mare as the workers feed the mother-bee. But while it may be allowable to mention these as interesting possibilities I do not propose to discuss them in this paper.

There is another element which is, I think, very important in fixing the definite type of the workers, and which I had intended to discuss. But while I think that element important in the bee and perhaps absolutely necessary for the still higher specialisation of the ant, I think also that a permanent body of workers is necessarily evolved from the conditions which I have assumed as natural and proper to the primitive bee.

To recapitulate in few words:

I presuppose a primitive bee fertile and affectionate, hoarding and intelligent.

I show that great want will necessarily diminish the number of her eggs.

That it will render some eggs imperfect by deranging the reproductive organs of the mother.

That consequently some of the offspring will be defective in the reproducing organs.

That while other imperfect bees will generally die before maturity, those imperfect only in the reproductive organs will live if the perfect offspring live.

That some of these being incapable of mating, will not go away for that purpose, but will stay with the mother-bee.

That, having surplus energy to expend, they will use it in accordance with the instinct of the race in gathering and storing food.

That the surplus food will be utilised by the mother-bee, and that therefore this family will be affluent.

That, being affluent, the formerly overtaxed mother will recover her health, and that her offspring will thereafter be perfect.

That consequently these nursemaid-bees will have no successors, and the family will therefore be again reduced to want.

That some bees of the same hatch with the nursemaids will be congenitally imperfect, notwithstanding that they leave the mother and find mates.

That the offspring of congenitally imperfect bees will be extremely variable.

That some of this offspring will be unable to reproduce and that they will remain with the mother-bee as nursemaids or helpers.

That these helpers from the congenital imperfections of their mothers will have successors; substantially as is seen among the hive-bees and the humble-bees of the present day, and

That the variation thus started will eventually be reduced to a definity type or to definite types—by the survival of the fittest.

That whatever other circumstances may aid in producing the result in question, this is sufficient of itself to account for the specialisation of the bee and the ant into females, males and workers.

SCIENCE IN FRENCH COCHIN CHINA

WE have already referred to an official publication of the French Colonial Government in Saigon, entitled *Excursions et Reconnaissances*, which appears every two months, and is wholly devoted to recording the investigations made by French officials in French Cochin China and the neighbouring semi-independent and independent States. The course and results of the numerous scientific missions despatched to these regions by the Ministers of Education and the Colonies, as well as the travels and researches of private individuals, are published in this periodical; and as there are six numbers published annually, of about 200 large octavo pages each, it will readily be perceived, apart altogether from the dearth of information, other than political, with regard to the great Indo-Chinese peninsula, that these volumes form a mine of knowledge of the most authentic and trustworthy description, for the writers are for the most part men who have been specially selected in France to study the subjects with which they deal. Unfortunately, however, the publication is but little known in this country, no copy being obtainable in some of our largest official libraries. As it is on sale in Saigon, and doubtless also in Paris, there is no reason why a periodical so valuable should not be made accessible to English students.

We have before us the three last numbers, and from them it is possible to obtain an idea of the scientific work which the French are performing in their new possessions. No department of research escapes their attention, and they are indefatigable in studying the country and people for whose welfare they have now become responsible. In one respect these volumes resemble those of many learned societies in India and elsewhere: they are extremely varied in their contents. Shafts have been driven in all directions, and the result is here; but when we recollect the short period that the French have been even at Saigon, the still shorter period that they have been able to travel in the interior, it will be apparent that no merely private society could accomplish the work done here. The traveller in most parts of Cochin China still requires a guard of twenty or thirty *tirailleurs*, which can only be provided by the Government. Again, few private persons, however enthusiastic, could afford to spend several years travelling over every part of Cochin China in search of ancient inscriptions, as M. Aymonier has done. Such work as this could, under the circumstances, only be performed with the assistance of Government; and it is greatly to the credit of the French Government that amongst its responsibilities in connection with colonies in the East, it recognises that of thoroughly investigating in a scientific manner the people and territories around them. It has often been said that the French are more sympathetic rulers of subject races than the English, and that they succeed sooner in gaining their affection; whether this be true or not, it is certain that they go the right way to rule properly, by setting themselves at the outset to comprehend what manner of people and of country it is that they are called upon to rule. Science, at any rate, gains by the French practice a consideration which is not very often present to the minds of our colonial rulers.

Geography naturally plays a considerable part in the *Excursions et Reconnaissances*, for a great part of Cochin China is still a *terra incognita*. For a like reason there is much that is specially ethnological. Thus, in the numbers before us we have two papers on the Mois tribes: one by M. Nouet, recounting a journey amongst the Mois on the north-eastern frontier; the other, by M. Humann, on the independent Mois. In the first these curious people are described as slothful and careless, knowing nothing of money, wandering about from place to place in search of subsistence, without any industry beyond producing articles which are absolutely necessary, and always hungry. They are excessively timid, flying into the forest on the approach of a stranger; they have no writing, and appear to have no religion either; they bury and burn the dead, but there are no subsequent ceremonies in connection with the departed. Even those within French territory lead a savage life; their existence is described as, not dying of hunger, rather than positive living. But the race is disappearing slowly from misery and disease; the prohibition against burning the forests is said to bear hardly on them, as it is the only method they know for clearing patches for the cultivation of their rice. The independent tribes, described by M. Humann, are braver than those which are found further south; they can work in iron, and appear more provident and less nomadic. But they live amongst the mountains, whither they have fled before the Annamites on one side and the Siamese on the other.

Dr. Tirant contributes a very long paper, extending over the last three numbers, on the reptiles of Cochin China and Cambodia. It does not profess to be complete, for an exhaustive study of the subject would require collections and books not to

be obtained at Saigon. That it must be tolerably full, however, appears from the list of serpents, of which there are 87 in all, 17 being poisonous, the rest harmless. The scientific name, the Annamite and Cambodian names, are given in each case.

The inscriptions scattered all over Cambodia, which, like the great ruins of Angkor, have come down from an earlier civilisation which has otherwise disappeared, have attracted much attention, and have now apparently reached a stage in which scholars are violently quarrelling about them. Papers on them, generally accompanied by copies of the inscriptions, appear in every number of the periodical. M. Aymonier was specially sent out from France to study them, and in less than three years he succeeded in obtaining a *corpus* of about 350 inscriptions. These are in many languages, the principal, however, being in Khmer, or ancient Cambodian; and their examination has thrown much light on the history of Cambodia in ancient times, and possibly on the ethnological problems of the Indo-Chinese peninsula. The general result of the investigation so far, represents the distribution of the inhabitants of the southern part of the peninsula in the first centuries of the Christian era as follows:—The Annamites were still confined to Tonquin, while the Chams occupied the coast of the present Annam; tribes more or less numerous called Chongs, Kouis, Samre, &c., occupied the present Cambodia and Southern Laos. Probably their social state was more advanced than that of the tribes still existing between the valley of the Meikong and the coast of Annam. The Laotian people spread along the valley of the Meikong from Luang Prabang in Siam to Lokhon, while the Siamese were scattered about in principalities in the centre of the country now occupied by them. There existed a primitive religion amongst all these tribes: in April they rendered homage to the spirits of the high places, and in October they offered of the fruits of the earth to the *manes* of their ancestors. They knew of the use of iron and made arms and tools for themselves, and they cultivated rice. Then came Indian traders, who penetrated by the Meikong River, founded small colonies, and reduced some of the natives to slavery. They established independent states, and from them we get the name Cambodia, originally a title of honour. Thus the present population of Cochin China is the result of two totally distinct races and civilisations—Indian and the aboriginal native. The inscriptions give the history of the Khmer dynasty down to the twelfth century.

M. Landes writes on the folk-lore of the Annamites, while M. Aymonier has another long paper entitled "Notes on the Laos," being a series of observations made during journeys in the Laos country, which he has not been able to work up into a connected paper on this curious people. They embrace every conceivable subject relating to the Laos: the geography of the country, their ethnological features, customs, rites. There are up to the last issue seventy-nine of these notes, referring to as many different points connected with these tribes.

A lengthy report by Dr. Burck, Director of the Botanical Garden at Buitenzorg, in Java, is printed. It contains an account of his exploration in the highlands behind Padang, on the west coast of Sumatra, in search of the trees which produce guttapercha. The present state of the subject is this: Specimens of guttapercha are found in considerable quantities in trade, but it is impossible with our present knowledge to determine the botanical origin of a single one of these specimens. The *Dichopsis gutta* (Benth.), the *Isonandra gutta* of Hooker, is the only species of tree producing guttapercha of which botanical specimens have been sent to Europe. But it has never been exactly and completely described, for no man of science has seen the fruit or seeds in their maturity. No one can at present affirm with certainty the origin of such or such a kind of guttapercha in trade. Dr. Burck maintains that the tree has never been found at Singapore and that since the disappearance of the forests there no one can affirm that the *Dichopsis gutta* can be found in its wild state. The paper is of considerable length and the writer disputes certain statements in the Kew reports with reference to the trees producing guttapercha and the places where they are found. An account of a journey in Siam and a translation of a long Tonquinese poem with copious explanatory notes and an excursus on Annamite literature are the remaining papers of these three numbers, the product of six months' work. At this rate the eastern part of the Indo-Chinese peninsula cannot long remain unknown to Europe.

Since the above was in type we have received the succeeding number (vol. ix. No. 22) of the periodical here referred to. It contains a report from M. Aymonier on a further journey of his in search of inscriptions, and describing in some detail the tribe of Chams in Cambodia. He promises a complete work later on this tribe in the province of Binthuan, which have been almost wholly unknown hitherto. The same writer concludes his valuable notes on the Laos, the present instalment dealing with the Kouis, the Khmers, and the province of Korat. These notes occupy more than half the whole number, and, in the present state of our knowledge of the Laos tribes, are simply invaluable, supplying as they do the results of long and close observation on the part of the only European traveller who has yet had an opportunity of living and travelling amongst them. M. Baux has a short encyclopædia sort of article on tea, which is of no especial note. M. Landes continues his folk-lore of Annamites, under the title "Contes et Légendes Annamites." So far he has given fifty popular tales and fables, in which we find many old friends. Androcles and the lion reappear, for example, as the midwife and the tigress, the reward being a pig caught by the latter and carried as a present to the woman. Dr. Tirant, having concluded his study of the reptiles, commences in this number a paper on the fishes of Lower Cochin-China and Cambodia. Fishes play here a preponderating zoological *rôle*; Southern Indo-China forms an ichthyological province closely allied with Malayasia; Lower Cochin-China in particular has curious affinities in this respect with Borneo. The present number contains only the first instalment of Dr. Tirant's "Notes," as he modestly styles a paper of great research and investigation.

ON THE MEASUREMENT OF MOVEMENTS OF THE EARTH, WITH REFERENCE TO PROPOSED EARTHQUAKE-OBSERVATIONS ON BEN NEVIS [1]

MEASUREMENTS of earth-movements are of two distinct types. In one type the thing measured is the displacement, or one or more components of the displacement, of a point on the earth's surface. For this purpose the mechanical problem is to obtain a *steady point*, to be used as an origin of reference, and this is effected by making use of the resistance which a mass opposes to any change of motion. This may be called the *Inertia* method of observing earth-movements. It is applicable to ordinary earthquakes, and also to the more minute earth-tremors which would pass unnoticed if instrumental means of detecting their presence were not employed. The steady point is to be obtained by suspending a heavy mass (with one, two, or three degrees of freedom) in such a manner that its equilibrium is very nearly neutral. Any moderately sudden displacement of the ground in the direction in which the mass has freedom to move leaves the mass almost undisturbed, and the displacement of the ground is therefore easily measured or recorded by a suitable autographic arrangement, which must be so designed as to introduce exceedingly little friction.

The second type of measurement is that in which the thing measured is any change in the inclination of the surface of the ground relatively to the vertical. Movements of this class have been examined by d'Abbadie and Plantamour, and also by G. H. and H. Darwin, who have given the results of their observations to the British Association in two reports on the lunar disturbance of gravity (1882-3). Perhaps the most convenient name for these movements is "earth-tiltings." They are measured by what may be called the *Equilibrium* method. A pendulum, suspended in a viscous fluid, is employed to show, by its equilibrium position, the true direction of the vertical, and that is compared with the direction of a line which is fixed relatively to the surface of the ground; or, instead of a pendulum, a dish of mercury or a pair of spirit-levels are employed to define a truly horizontal surface, and the tilting of the earth's surface relatively to that is observed. This method is practicable only when the displacements of the surface have so great a vertical amplitude, in comparison with their horizontal wave-length, that the slope of the wave is sensible; and, further, only when the changes of slope occur slowly enough to put the inertia of the pendulum or fluid out of account.

On the other hand, the inertia method is applicable only when the displacements have so short a period, in comparison with their amplitude, that the acceleration of the ground, during

[1] Paper read before Section A of the British Association at Aberdeen, by Prof. J. A. Ewing, of University College, Dundee. (Abstract.)

the greater part of the motion, is large relatively to the frictional resistance of the suspended mass.

Between ordinary earthquakes and tremors, on the one hand, capable of observation by the inertia method, and slow earth-tiltings, on the other, capable of observation by the equilibrium method, it is at least possible that there may be many movements, not reducible to either type. For example, if successive upheaval and subsidence of small amplitude were to occur with a very long horizontal wave-length, and with a period of (say) one or two minutes or more, it would be practically impossible even to detect its existence by either of the methods named, unless by chance it were repeated several times with uniform period in the presence of a very frictionless vibrator whose free period happened to agree nearly with the period of the disturbance; even then, no measurement of its amount could be made. We are in fact forced to classify earth-movements under the two heads which have been named, not because there is any necessary discontinuity between the two, but because they must be treated by two entirely distinct modes of observation.

For the measurement of palpable earthquakes by the inertia method, the writer has devised many instruments which have been successfully applied to the registration of Japanese earthquakes, and which are described in a memoir on earthquake measurement, published in 1883 by the University of Tokio. He has not attempted in any case to give the astatically suspended mass three degrees of freedom, and nothing would be gained by doing so. An instrument with two degrees of freedom is now exhibited to the Association. It consists of an ordinary pendulum coupled with an inverted pendulum, in such a manner that the two bobs move together in any horizontal direction. This combination of a stable with an unstable mass can be adjusted to give any desired degree of astaticism. In practice it is convenient to allow the joint mass to have a free period of from five to ten seconds, the period of ordinary earthquake waves being much less than this. A long and light lever, pivoted to the frame of the instrument at one point, and to the steady mass at another, forms a registering index, by which a magnified trace of the earth's horizontal movement is deposited on a fixed plate of smoked glass with the least possible friction.

In another instrument two components of horizontal motion are separately determined, each by a horizontal pendulum, tilted slightly forwards to give a small degree of stability, and furnished with a multiplying pointer. In this instrument the pointers trace the successive movements of the earth on a plate of smoked glass which is kept revolving uniformly by clockwork. The velocity and acceleration of the movements are deducible from the records. This is the standard form of seismograph employed by the writer, and, to make the information it gives complete, another instrument for registering (on the same plate) the vertical motion of the ground is added.

The vertical-motion seismograph is a horizontal lever, supported on a horizontal fixed axis, and carrying at one end a heavy mass. A spring attached to a fixed point above holds up the lever by pulling on a point near the fulcrum. To make the mass nearly astatic the point at which the spring's pull is applied is situated below the horizontal line of the lever, so that when the spring, by (say) being lengthened, pulls with more force, the point of application moves nearer the fulcrum, and the moment of the pull remains very nearly equal to the moment of the weight.

Apart from its application to palpable earthquakes the inertia method is to be applied to minute earth-tremors of the kind observed in Italy by Bertelli and Rossi, which are probably to be found wherever, and whenever, one searches for them with sufficient care. But in dealing with them no mechanical means of recording can well be applied, on account of its friction, and a still more frictionless method of suspending the heavy mass is desirable. The writer prefers for this purpose a mode of suspension based on Tchebicheff's approximate straight-line motion; and to detect the movement of the ground he observes, by a microscope fixed rigidly to the frame of the machine, the displacement of the frame with respect to the suspended mass. This is Bertelli's method, except for the substitution of a nearly astatic mass for the stable mass used by him—namely, the bob of a short pendulum—which of course gives a misleading magnification of certain vibrations.

The writer was recently requested by the Directors of the Ben Nevis Observatory to design seismometers for use there, and obtained a Government grant for their construction. The equipment at Ben Nevis will include recording-seismographs, and a micro-seismometer of the kind just described. To measure slow earth-tiltings an instrument is being constructed in which a modification (due to Wolf) of d'Abbadie's arrangement (described in Prof. Darwin's Reports) is followed. Light from a lamp travels some twenty feet horizontally to a mirror inclined at 45° to the horizon. It passes vertically down through a lens which brings the rays into parallelism. They then strike two reflecting surfaces—one the surface of a basin of mercury, the other a plane mirror very rigidly fixed to the rock. The rays come back to form two images near the source, and any relative displacement of the two images is measured by a micrometer-microscope. In the choice and design of this instrument the writer has to acknowledge much assistance from Prof. G. H. Darwin. This apparatus, like the others, was intended for Ben Nevis, but a visit to the Observatory there has convinced the writer that to use it on that site, and in the atmosphere which prevails on the top, would be a matter of extreme difficulty, and that, in the first instance at least, observations should be made with it on lower ground.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Prof. P. G. Tait has been elected an Honorary Fellow of Peterhouse; and Mr. T. T. Jeffery, M.A., a Fellow of the same College.

Mr. J. Larmor, M.A., of St. John's College, has been appointed one of the University Lecturers in Mathematics, and also Examiner for the First Part of the Mathematical Tripos of 1886.

The Syndicate appointed to re-arrange the additional subjects of the Previous Examination have reported in favour of adding Elementary Dynamics to Statics, and reducing the Trigonometry to what is needed for the Examination in Mechanics; Mathematical Honour students, they recommend, shall no longer be required to pass this Examination, but instead be required to pass in either French or German. Physical Science and Biology are still to receive no recognition even as optional subjects.

Dr. Burghardt, Lecturer in Mineralogy in Owens College, Manchester, is appointed to examine in Mineralogy in the Natural Sciences Tripos; Prof. Ray Lankester, F.R.S., to examine in Zoology and Comparative Anatomy in the same Tripos, the First M.B., and the Special Examinations.

Christ's College offers Scholarships and Exhibitions for Natural Science, the Examination beginning January 5, 1886. The Examinations at Jesus College begin on the same day.

The Special Boards for Physics and Chemistry and for Biology and Geology have issued the following notice with regard to the First Part of the Natural Sciences Tripos:—

In Part I. of the Examination all the questions will be of a comparatively elementary character, and will be such as to test a knowledge of principles rather than of details. Specimens may be exhibited for description and determination.

In Physics the questions will be limited to the elementary and fundamental parts of the subject, and, in particular, special attention will be paid to the definition of physical quantities, the general principles of measurement, the configuration and motion of a material system, the laws of motion, the comparison of forces and of masses, and the properties of bodies. In Sound, Light, Heat, Electricity and Magnetism, only the fundamental laws, their simpler applications, and the experiments which illustrate them, will be required.

In Chemistry the questions will relate to the leading principles and experimental laws of Chemistry, the properties of the commoner elements and their principal compounds, the outlines of Metallurgy, and simple qualitative and quantitative analysis.

In Mineralogy the questions will be confined to elementary Crystallography, the general properties of minerals and the special characters of those species only which are of common occurrence or of well-known mineralogical importance.

In Geology the questions will be limited to Physical Geography, the interpretation of the structure of the crust of the earth and the history of its formation, so far as to involve only the elementary parts of Palæontology and Petrography.

In Botany the questions will relate to the elementary parts of Vegetable Morphology, Histology, and Physiology; and to the principles of a natural system of classification as illustrated by the more important British natural orders. Candidates will be required to describe plants in technical language. Question

will not be set on Vegetable Palæontology or the Geographical Distribution of Plants.

In Zoology and Comparative Anatomy minor details will not be included in the questions relating to classification. Geographical distribution of animals is held to be a part of Zoology, and Comparative Anatomy includes the structure of extinct as well as of recent forms.

Human Anatomy will include the mechanism of the human body, the comparison of its parts with those of lower animals, its development, &c.; but the questions will be of a simple and elementary character.

In Physiology the questions will be of a comparatively elementary character.

A practical examination will be held in each of the above subjects.

SCIENTIFIC SERIALS

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft in Zürich, August 7–9, 1883.—We note here the opening address by Prof. Cramer, on unicellular fungi.

Verhandlungen der Naturhistorischen Vereines der preussischen Rheinlande, Westfalens, und der Reg.-Bezirks Osnbrück, 42nd year, first half, 1885.—The greensand of Aacken and its molluscan fauna, by J. Böhm.—The forest vegetation of the outer North-western Himalaya, by D. Brandis.—On Devonian Aviculaceæ, by O. Follmann.—The biology of water plants, by H. Schenck.

Nouveaux Mémoires de la Société Helvetique des Sciences Naturelles, vol. xxix. part 1, 1884.—Geological sections of the Tunnels of Doubs, by M. Mathay.—On the nisal flora of Switzerland, by M. Heer. Fossil woods from Greenland, by M. Beust.

SOCIETIES AND ACADEMIES

London

Mathematical Society, November 12.—J. W. L. Glaisher, F.R.S., President, in the chair.—Mr. L. J. Rogers, Balliol College, Oxford, was elected a member.—The following gentlemen were elected to form the Council for the ensuing Session:—President: J. W. L. Glaisher, F.R.S.; Vice-Presidents: Dr. O. M. Henrici, F.R.S., Prof. Sylvester, F.R.S., J. J. Walker, F.R.S.; Treasurer: A. B. Kempe, F.R.S.; Secretaries: M. Jenkins, R. Tucker; other Members of the Council: Prof. Cayley, F.R.S., Sir J. Cockle, Knt., F.R.S., E. B. Elliott, A. G. Greenhill, J. Hammond, H. Hart, C. Leudesdorf, Capt. P. A. Macmahon, R.A., Samuel Roberts, F.R.S.—The following communications were made:—On waves propagated along the plane surface of an elastic solid, by Lord Rayleigh, F.R.S.—On the application of Clifford's graphs to ordinary binary quantics, by A. B. Kempe, F.R.S. (Messrs. Hammond and Macmahon put questions to the author).—On Clifford's theory of graphs, by A. Buchheim.—On unicursal curves, by R. A. Roberts.—On some consequences of the transformation formula $y = \sin(L + A + B + C + . -)$, by J. Griffiths.

Linnean Society, November 5.—Sir John Lubbock, Bart., President, in the chair.—Mr. T. Christy exhibited orchids of the genus *Catasetum*, showing that owing to the plants having been moved, the flower in both instances had become malformed.—Mr. E. A. Heath showed a golden eagle in its characteristic plumage of the second year.—Mr. J. Carter exhibited a collection of seeds, lately introduced, remarkable for their peculiarities as specimens under the microscope.—There was shown for the Baron von Mueller a collection of skeleton leaves of species of *Eucalyptus*, prepared by Mrs. Lewellin of Melbourne. These confirm Baron von Mueller's observations as to definite layers, and the relation of these to the skeletonising process. The leaves in decaying produce no bad odour. Von Mueller's observations do not support M. Rivière's statement that the bamboo is as good as eucalypts to subdue malaria; the former dry up, but do not exhale volatile oil as do the latter, and the eucalypts moreover absorb moisture as quickly as Willows, Poplars, and Bamboos.—Dr. Ondaatje showed examples of walking-sticks from Ceylon palms, viz. the Kittool Palm (*Cayota urens*), the Areca and Cocoa-nut.—Mr. J. G. Baker made remarks on an exhibition by Mr. Thiselton Dyer of Darwin's potato (*Solanum meglia*), grown at Kew, the weight of twelve tubers being 28 oz.; also the "papa de Oso," Bear's potato (*S. tuberosum*, var.), grown out of doors from tubers received from Dr. Ernst of Caracas, who obtained them from Merida, where they are found wild.—Then followed a paper, viz. contributions to the flora of the Peruvian Andes, with remarks on the history and origin of the Andean flora, by Mr. John Ball. In this paper the author says that his statements chiefly refer to the western slope of the Cordilleras. From the collections made and other data, so far, therefore, a this region of Peru is concerned, it may confidently be averred that the limit of Alpine vegetation has been placed by previous writers on the subject far too low. In the present instance there can be no serious error as to heights, seeing these are based on those of the railway engineers. The explanation of this relatively high extension of the temperate flora depends on the peculiar climatical conditions. Rain occurs but sparingly, the nights are cold, but frost scarcely known; whereas in the plateau region eastward storms, heavy snow, and frosts are frequent. The vegetation of the region visited Mr. Ball divides into a sub-tropical dry zone from coast to 8000 feet, a temperate zone reaching to 12,500 feet, and an Alpine zone upwards to 17,000 feet, above the sea-level. As regards the proportion in which the natural families of plants are represented in the Andean flora, the Compositæ amount to nearly one-fourth of the whole species, the grasses equal one-eighth, the Scrophularineæ supply five per cent., while Cruciferæ, Caryophylleæ, and Leguminosæ each are represented by about one-thirtieth of the whole. The Cyperaceæ are conspicuous by their absence; a remarkable feature is the presence of four Crassulaceæ. If we take the proportions of the endemic genera and species as criteria, then, as far as materials admit, the Andean flora appears to be one of the most distinct existing in the world. Mr. Ball agrees with those who think it probable that the south polar lands constitute a great archipelago of islands. To this region in question he is inclined to refer the origin of the Antarctic types of the South American flora.—The first part of an exhaustive monograph on recent Brachiopoda, by the late Dr. Thos. Davidson, was read by the Secretary. In this part of his contribution the author reviews the labours of his predecessors in the field, with regard to the shell, to the anatomy of the adult, and to the embryology. As regards the perplexing question of affinities he remarks:—"Now, although I do not admit the Brachiopoda to be worms, they may, as well as the Mollusca and some other groups of invertebrates, have originally diverged from an ancestral vermiform stem, such as the remarkable worm-like mollusk *Neomenia* would denote." He lays stress on the brachiopodous individual being the product of a single ovum, and not giving rise to others by gemmation. He considers that the shell, the pallial lobes, the intestine, the nerves, and the atrial system, afford characters amply sufficient to define the class. The greatest depth at which a living species has been found alive has been 2990 fathoms. As to classification, he groups the recent species into two great divisions:—(1) Anthropomata (Owen) = Clistenterata (King), (2) Lypomata (Owen) = Tretenterata (King). The Anthropomata he groups in 3 families:—1st Fam. Terebratulaceæ, with 7 sub-families and 13 genera and sub-genera, 70 species, and 21 uncertain species. 2nd Fam. Thecideidæ, with 1 genus and 2 species. 3rd Fam. Rhynchonellidæ, 1 genus, 1 sub-genus, and 8 species. The Lypomata he also groups into 3 families, 5 genera and sub-genera, 23 species, and 7 uncertain species:—1st Fam. Craniidæ, with 1 genus and 4 species. 2nd Fam. Discinidæ, with 1 genus, 1 sub-genus, and 8 species. 3rd Fam. Lingulidæ, with 1 genus and 1 sub-genus, and 11 species. He does not concur with M. Delongchamps' scheme (1884) of classifying the Terebratulina, bringing forward Mr. Dall's observations on *Waldheimia floridana*, of delicate spiculæ in the floor of the great sinuses as telling evidence against the arrangement. Dr. Davidson then proceeds to treat of the various genera and species, adding remarks in detail on the Terebratulaceæ from his standpoint, and throughout gives copious descriptions and observations on each.

Royal Microscopical Society, October 14.—The Rev. Dr. Dallinger, F.R.S., President, in the chair.—Mr. Crisp exhibited D'Arsonval's water microscope, a suggestion for improving the means of focusing. The body-tube of this extraordinary instrument contained a glass cylinder which was connected by an india-rubber tube with a syringe. On turning the handle of the syringe water was forced into the cylinder, and the focus was altered according as more or less water was pumped in. Of course, an alteration of focus did result from the operation, but the arrangement destroyed the correction of the objective, and wa-

otherwise objectionable.—Mr. J. Mayall, jun., described Riddell's binocular microscope, which was exhibited by Mr. Crisp, and was of considerable interest, as having been the first binocular microscope with a single objective. He pointed out as a noteworthy feature that it was provided with a means of separating the prisms, so as to give to each eye-piece a full field of view. There was also a screw with a right- and left-handed thread for separating the tubes to suit the width between the observer's eyes. An ingenious application of reflectors at the top of the eye-pieces effected a perfect inversion of the image, so that the instrument could be used for dissecting purposes. It was also a point of special interest in the history of the development of the binocular microscope, that so early as this Prof. Riddell had applied two mirrors for the purpose of equalising the illumination in both fields.—Mr. Crisp exhibited a "twin" simple microscope having two lenses of different powers, also two forms of magnifiers sent by Mr. Hippisley as examples of the capabilities of lenses made out of spherules of glass, and of a simple method of holding them.—Dr. Maddox read his paper, further experiments on feeding insects with the curved or "comma" bacillus.—Mr. Crisp said they had received six slides of material taken from the intestines of Lieut. Kisslingbury, U.S.N., one of the victims of the unfortunate Greeley Arctic Expedition. When the question of cannibalism was being discussed, his body was exhumed, and a good deal of the flesh was found to have been cut off the bones. In order to ascertain if possible what was the last food of which the deceased had partaken, and to establish whether the officers had joined in the cannibalism of the men, the contents of the stomach were submitted for examination. The letter of Mr. C. E. Alling, accompanying the slides (which were sent by Dr. Mandeville and himself) was read to the meeting. Mr. Groves said that although it might be possible to say, from an examination of these slides, whether the material consisted of the flesh of a mammal, a bird, or a fish, it would be quite impossible to say if it was human flesh or not, unless it happened that some hair had been taken with it. Mr. Crisp said that this opinion was confirmed by Prof. Stewart of the Royal College of Surgeons, who, however, thought that a means of identification might be found in the small hairs of the general surface of the body. The slides, however, showed no such hairs.—Mr. P. D. Penhallow's note as to a handle for cover-glasses was read.—Mr. C. Beck exhibited a compact form of Mr. Stephenson's catadioptric illuminator.—Mr. Kitton's and Mr. Kain's notes on balsam of Tolu were read, and Mr. Kitton's note on a new diatom, *Navicula Durrandii*.—Mr. J. C. Stodder's note was read, giving the views held by the late R. B. Tolles on the formation of a small battery of objectives to cover reasonably well all the requirements of the general microscopist: 3 in., 1 in. (30°), 4-10 in. (110° dry), 1-10 in. (oil-glycerin-water immersion with a balsam angle of not much less than 120° for best results).—Mr. C. D. Ahrens' paper on an improved form of Stephenson's erecting and binocular prisms was read, in which he proposed to unite the lower prisms by a wedge of glass. He also proposed an alteration in the upper prisms (when they are used in place of a plate of glass).—Mr. T. B. Rosseter's paper on the uses and construction of the gizzard of the larva of *Corethra plumicornis* was read by Prof. Bell, and prepared specimens in illustration exhibited.—Mr. Dowdeswell's paper on the cholera comma-bacillus was read.—The President called the attention of the meeting to the death of Mr. Robin, the eminent histologist, and one of the Honorary Fellows of the Society.—Seventeen new Fellows were elected and proposed.

PARIS

Academy of Sciences, November 9.—M. Jurien de la Gravière in the chair.—Determination of the mechanical work effected in human locomotion (one illustration), by MM. Marey and Demeny. This is an attempt to estimate the quantity of muscular energy developed by man in the various forms of locomotion from the physiological standpoint, which is shown to be different from the mechanical. Three chief elements in the measurement of muscular action in horizontal movement are here considered separately: The labour expended along the vertical; the labour expended along the horizontal; and the labour required for the oscillation of the lower member during its suspension.—Variations in the mechanical labour expended in the different attitudes of man during locomotion (three illustrations), by the same authors. The estimates here recorded are the results of experiments made on two persons only, walking and running on the level. The experiments will require to be repeated on a large number of subjects in order to determine the influence of weight, height, slope of the ground, and thus arrive at a mean average.—On the radicular nature of the stolons of Nephrolepis: a reply to M. P. Lachmann, by M. A. Trécul.—On the derivation of the solutions in the theory of the Cremona transformations, by M. de Jonquières.—Note on the combe of Péguère, near the thermal station of Cauterets, Pyrenees, by M. Demontzey. The destructive landslips to which this upland valley has long been subject, are shown to be due to denudation and erosive action, hence may be prevented by gradually restoring the vegetation along the steep slopes of the surrounding mountains.—Experimental researches tending to show that the muscles affected by *rigor mortis* remain endowed with vitality till the appearance of putrefaction, by M. Brown-Séquard. Experiments made on dogs some days after being killed seem to render it probable that muscular rigidity is not a state of absolute death, but a transition from life to death, a transition which may last for weeks.—On the action of a mixture of sulphate of copper and lime on the mildew of the vine, by MM. Millardet and U. Gayon.—Analytical theory of the movements of Jupiter's satellites, second part: Reduction of the formulas to numbers, by M. C. Souillart.—An undated letter of the Countess de Lafayette (reign of Louis XIV.) addressed to Segrais, and inviting him to witness "the experiment with an artificial fire giving warmth the whole day for two sous," by M. Feuillet de Couches.—Application of M. Lœwy's new methods for the determination of the absolute co-ordinates of the circumpolar stars without the necessity of ascertaining the instrumental constants (right ascensions), by M. Henri Renan.—On the numerical tables intended to facilitate the transformations of co-ordinates in astronomical calculations, by M. Vinot.—On the irregular integrals of linear equations, by M. H. Poincaré.—Note on the compressibility of fluids, by M. E. Sarrau. The formula—

$$p = \frac{RT}{v-a} - \frac{K}{T(v+\beta)^2}$$

proposed by M. Clausius for carbonic acid, in which p = the pressure, v = volume, and T = absolute temperature, is shown to be applicable to other gases. The author claims that for these gases he had deduced the elements approaching the critical point before the experiments of MM. Wroblewski and Olszewski.—On two new kinds of radiophones, by M. E. Mercadier. With these instruments, which he names the "thermo-electrophone" and the "thermo-magnetophone," the author thinks it will be possible, with an intense solar radiation, to reproduce articulate speech.—An explanation of the anomalous magnetic effects produced by the discharges of condensers, by M. Ch. Claverie.—Note on Schlœsing's law respecting the solubility of the carbonate of lime by carbonic acid, by M. R. Engel.—On a coloured reaction of rhodium, by M. Eugène Demarçay. Certain blue solutions of rhodium yield with potassa a greenish precipitate, which changes to a dark blue in acetic acid. This colouration appears due to the formation of a salt corresponding to the green hydrate of bioxide of rhodium.—On the antiseptic and other properties of rosolene (retinol, $C_{32}H_{16}$), by M. Emile Serraut.—On the root of *Danais fragrans*, Comm. (yellow liane) and its chemical composition, by MM. Edouard Heckel and Fr. Schlagdenhauffen.—On the composition and fermentation of interverted sugar, by M. Em. Bourquelot.—On the hypnotic properties of phenylmethylacetone (acetophenone), by MM. Dujardin-Beaumetz and G. Bardet.—On the nervous system of Phylloxera, by M. Victor Lemoine.—On the Limaciæ of the neighbourhood of Saint-Vaast la Hougue, department of La Manche, by M. S. Jourdain.—Variations in the respiration of plants at the different stages of development, by MM. G. Bonnier and L. Mangin.—On a rare amygdaloid granite from the Riaillé Quarry, Saint-Hilaire de Loulay, Vendée, by M. Stanislas Meunier.—On some fragments of human skulls and a potsherd found in immediate association with two skeletons of *Ursus spelæus* in the Nabrigas Cave, Lozère, on August 28, 1885, by MM. E. A. Martel and L. de Launay. The discovery of these remains seems to place beyond doubt the existence of man already possessing a knowledge of the potter's art at the epoch of the Cave bear in the Lozère district.—On the relation of whirlwinds and waterspouts to cyclones, by M. Ad. Nicolas.—Remarks on M. Jourdy's "Geology of East Tonkin," by M. Albert Gaudry.

BERLIN

Meteorological Society, October 13.—The President, Geheimrath Dr. Thiel, reported that, in accordance with a resolution passed by the Society in furtherance of the establishment of a thickly planted series of rain-stations, rain-gauges had been set up at seven places in the outskirts of Berlin to the north-west and west, and since July had been working well. It was to be hoped that their number would soon be increased and that a lengthened series of observations would yield data for an exact determination of how closely rain-gauges must be placed to each other, in order to obtain a correct representation of the rainfall of any district.—Dr. Hellmann then, after a brief historic survey of the institution of meteorological stations at high points, gave a full description of the meteorological observatory at Ben Nevis in Scotland, which he had visited in August last. The topographical situation of the station, the construction and position of the instruments, and the mode of observation were set forth, while some of the climatic peculiarities of this station, such as its great humidity, its small yearly and daily variations of temperature, its scanty sunshine, the frequent reversal of the change of temperature with the height, and other particulars, were also remarked on. Following up the minute description of this important high station in Scotland Dr. Hellmann enumerated all the stations on the peaks of mountains that had hitherto been erected, which comprised only the Puy de Dôme and Pic du Midi in France, the Säntis in Switzerland, the Schafberg and Hochobir in Austria, the Schneekoppe and Brocken in Prussia, and Mount Washington and Pike's Peak in the United States of America. Of these stations only the two French, the Swiss, and the Austrian were of the first rank, or between the first and second rank. In addition to these stations on mountain tops there was a whole series of high situated meteorological stations on mountain passes and plateaus in operation, which collected valuable material towards the meteorology of the higher atmospheric strata, in Italy, Switzerland, Germany, India, South America. In the case even of a temporary residence at high situated points brief but very valuable series of observations had been gained—at Ararat, for example. It must, nevertheless, be the endeavour of scientific meteorology to increase the number of mountain-top stations of the first rank, and the speaker expressed the hope that under the contemplated reorganisation of the meteorological service in Germany, and particularly in Prussia, at least one mountain-top station of the first rank, namely, on the Schneekoppe, which was very peculiarly adapted for this purpose, would be established. In the discussion which followed it was maintained on one hand that self-registering instruments at high stations were perfectly useless, and on the other hand that even tourists, many of whom every summer reached heights beyond 4000 metres high, might, by means of portable pocket instruments, supply contributions quite available towards the meteorology of the higher strata. A member of the Society gave some proofs to this effect, and mentioned the remarkable fact that the red-brown ring round the sun, which he had everywhere seen distinctly, appeared from Monte Rosa, not red-brown, but very distinctly reddish-yellow.—Dr. Börsch related that during a determination of longitude between Berlin, Breslau, and Königsberg, the observer in Berlin on August 2 was sensible of such lively disturbances of his level that he was obliged to discontinue for a time the use of the transit instrument, and considered the oscillations to be seismic. When he afterwards read in the newspapers of violent earthquakes in the interior of Asia having happened at the same time, he made inquiry of the observers at Breslau and Königsberg, and learnt that they too had been disturbed by lively oscillations of the ground. These vibrations had been all the stronger the more to the east was the station, a circumstance which likewise pointed to a connection with the earthquakes of the interior of Asia. More careful observation of such phenomena would render possible the exact measurement of the propagation of earth-vibrations.

VIENNA

Imperial Academy of Sciences, July 2.—Researches on the structure of striped muscles, by A. Rollett.—Contributions to general nerve and muscle physiology (eighteenth communication), on inhibitory effects produced by electrical stimulation of striped muscles and on positive cathodic polarisation, by W. Biedermann.—On pyroracemic glycide ethers, by F. Erhart.—Contributions to the theory of respiratory innervation (fifth communication), by Ph. Knoll.—Studies on the endosperm of some Gramineæ, by E. Tangl.—On a new hydrodensimeter, by A. Handl.—On the nutrition of ganglion cells, by A. Adamkiewicz.—On cyanhydrines of nitroso-compounds, by E. Lippmann.—Contribution to the knowledge of dichinolins, by O. W. Fischer.—On benzoyl-ecgonine and on its transformation to cocaïne, by Zd. H. Skraup.—Statistics of earthquakes from 1865 to 1885, by W. C. Fuchs.—Contribution to the morphology and anatomy of the Coccida, by E. Witlacil.—On the Lower Eocene formation of the Northern Alps and on its fauna (Part I. Lamellibranchiatæ), by K. F. Frauscher.—On para-chloraldehyde, by C. Natterer.—On the action of phenol and sulphuric acid on hippuric acid, by T. Zehenter.—On the gum-ferment, a new diastatic enzyma, by which the formation of gum and mucilage in the plants is induced, by F. Wiesner.

July 16.—Note on the meteorites of Angra dos Rais (Brazil), by G. Tschermak.—A contribution to the theory of the mechanics of explosion, by E. Mach and T. Wentzl.—On the anatomy of Tyroglyphidæ, by A. Nalepa.—Contributions to the theory of respiratory innervation (sixth communication), by Th. Knoll.—On the products of decomposition formed by the action of hydrochloric acid on albumins; II. on elastin, by T. Horbaczewski.—Researches on the cloacal epithelium of Plagiostomata, by T. H. List.—On chloro- and bromo-derivatives of phloroglucin, by R. Benedict and K. Hazura.—On the action of potassium cyanide on dinitro-derivatives of organic bases, by E. Lippmann and F. Fleissner.—Note on hydrobromo-apoquinine, by P. Julius.—On the action of ammonia on anthragallol, by G. von Georgevics.—On the behaviour of liquid atmospheric air, by T. Wroblewski.—On ethylsulphuric acids of some carbohydrates, by M. Hœnig and St. Schubert.—Contribution to chemistry of cerium-metals, by B. Brauner.—On the elements and ephemeris of Barnard's (Nashville) comet (July 7, 1885), by E. Weiss.—On the meteoric fall observed on March 15, 1885, by E. Holletschek.—Studies on pyridine-derivatives, by H. Weidel and F. Blau.—On the electric and thermic properties of salt-solutions, by James Moser.—On the formation of striped fibres from sarcoplasts, by T. Paneth.

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